offshore labrador initial environmental assessment

scientific review

PETRO-CANADA

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LETTER OF TRANSMITTAL
SCIENTIFIC REVIEW:
PETRO-CANADA'S OFFSHORE LABRADOR
INITIAL ENVIRONMENTAL ASSESSMENT

This document is a summary of the scientific review of Petro-Canada's Offshore Labrador Initial Environmental Assessment (IEA), produced in January 1982. The IEA attempted to evaluate the effects of exploration for oil and natural gas on the physical, biological and human environment of Labrador.

To facilitate a rigorous scientific review of the IEA, Petro-Canada invited approximately fifty environmental scientists to a review seminar which was held May 21-24, 1982 in St. John's, Newfoundland.

The review seminar's tasks were to evaluate the scientific merit of the baseline information in the Offshore Labrador IEA, to provide criticism of the way the baseline information had been interpreted to form an environmental assessment and to make recommendations for further environmental studies on the offshore Labrador area.

Section I of the document is an overview of the multi-disciplinary scientific review. The overview attempts to define a consensus of diverse scientific opinions in areas of major concern and to use this perceived consensus to help design future environmental assessments which will better meet the requirements of both industry and regulatory bodies. Section II presents the wide-ranging discussions held during the scientific review seminar. Debate was lively and sometimes contradictory conclusions appeared in the proceedings. Nevertheless, the discussion and debate provided the basis for a free and very valuable interdisciplinary exchange of thoughts from which the seminar consensus might be derived. Section III presents the written review comments on the Offshore Labrador IEA from the Department of Fisheries and Oceans, Environment Canada and the Bedford Institute of Oceanography.

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In order to place a perspective on both the listed seminar comments and the written government comments, Petro-Canada has prepared matching responses. These commence in Section II with the Group I discussion in Session A.

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Section I

1.0 OVERVIEW OF THE OFFSHORE LABRADOR IEA SCIENTIFIC REVIEW SEMINAR

1.1 Introduction

This document is Petro-Canada's response to the scientific review seminar which was held to review and evaluate the Offshore Labrador Initial Environmental Assessment (IEA). The review seminar took place May 18-20, 1982, in St. John's Newfoundland and was attended by approximately fifty experts from government, the academic community, public interest groups, environmental consulting firms and Petro-Canada.

In staging the review seminar, Petro-Canada's intentions were several. First, it hoped to obtain an open, multi-disciplinary review of the accuracy and scientific merit of the Labrador IEA. Free discussion among scientists working in many different disciplines would, it was hoped, elucidate the interrelationships between oil exploration and the ecological processes operating in the Labrador Shelf. Second, Petro-Canada hoped that the review seminar would provide guidelines for improving future environmental assessments. Finally, it hoped that the insights gained from the review seminar would provide direction in the design of environmental studies planned in Labrador and elsewhere.

The diversity of scientific expertise at the review seminar assured a rigorous evaluation of the Offshore Labrador IEA. It also guaranteed diverse and sometimes conflicting opinions about the merits and flaws of this document, and there were wide-ranging discussions about the kinds of information an environmental assessment should contain. As a result, the proceedings of the seminar are a heterogeneous mixture of verifiable fact, subjective evaluation, speculation and recommendations for further research. Nevertheless, within the welter of fact and opinion, criticism and praise, there were several recurrent themes in the review seminar. These can be grouped under the following headings:

1. purpose of writing the IEA
2. timeliness of the IEA
3. evaluation of the accuracy, completeness and currency of the baseline data
4. interpretation of the baseline data to form an environmental assessment
5. recommendations for further research
6. guidelines for preparing environmental assessment documents

Petro-Canada's response to the review seminar follows these general themes.

1.2 Purpose of the Offshore Labrador IEA

Several of the participants in the review seminar wondered why Petro-Canada had bothered to prepare the IEA at all, because the IEA is not a part of any existing Environmental Assessment Review Process (EARP).

In brief, Petro-Canada prepared the Labrador IEA because the Canadian Oil and Gas Lands Administration (COGLA) requested it. As stated in Section 2.4.2 of the IEA, the document's purposes were to:

- describe the content and scope of existing environmental information with respect to offshore Labrador
- evaluate that information in the context of ongoing exploratory drilling and potential hydrocarbon production
- identify and priority rate additional environmental studies off Labrador

Concern for the environmental safety of exploratory drilling for oil and gas in an ice-infested environment had been expressed by LeDrew and Gustajtis (1979), by South _et al_. (1979), and in a Symposium on Research in the Labrador Coastal and Offshore Region (1979). A function of the Offshore Labrador IEA was to draw together as much of the existing environmental information as possible in order to provide preliminary answers to the environmental issues raised by those documents.

A final reason for producing the Offshore Labrador IEA was to remedy a perceived historical shortcoming in the environmental review process. Exploratory drilling off Labrador began in 1971, before the EARP process was instituted by the federal government in the mid-1970's, and before it became a regulatory requirement to produce environmental assessments to support new proposals for offshore hydrocarbon exploration. The Offshore Labrador IEA was produced so that the environmental assessment and review information would be more consistent with current regulatory requirements of government.

1.3 Timeliness of the Offshore Labrador IEA

A major criticism by the scientific review seminar was that the Offshore Labrador IEA was written too soon. Some participants felt that the writing of the IEA ought to have been deferred until the OLABS program was complete. The writing of the IEA began in December 1980. The document was edited; subjected to in-house, industry, and COGLA review; and finally printed in January 1982.

During the year it took to write the IEA, the amount of baseline information concerning the Labrador Shelf was expanding rapidly. In 1980 alone, an extensive current meter study, performed under the LABORS program, virtually doubled the amount of information on the circulation of the Labrador Shelf. Analyses of zooplankton, fish feeding and marine mammal feeding studies were proceeding under OLABS, and aerial surveys for seabirds and marine mammals were begun. Meteorological data from drilling locations were accumulating rapidly and mapping of factors affecting shoreline sensitivity was begun. A year after the writing of the IEA began, the LABORS program was still collecting information on the physical environment and most of the data will be collected and analyzed by late 1982. 1982 will be the final year of OLABS studies, but several months will pass before all the OLABS information is presented in final reports.

Knowing that the environmental information about the Labrador Shelf was accumulating rapidly, some participants felt that Petro-Canada ought to have deferred writing the Offshore Labrador IEA until all the results of environmental studies had been analyzed. Some participants even referred to six-month old information as "dated".

So long as the Labrador Group of Companies is operating on the Labrador Shelf, it will continue an active environmental studies program, because such studies (especially those concerning ice, physical oceanography and meteorology) are required by government regulations. Federal fishery and marine mammal studies will continue, for the purposes of stock assessment and setting quotas. Thus, the Labrador data base is unlikely to be "complete" in the foreseeable future. More to the point, the contention that Petro-Canada ought to have deferred writing the IEA until "all the data are available" is invalid.

Petro-Canada will not issue an "updated" version of the Offshore Labrador IEA, incorporating the most recent results of environmental studies. Periodic revisions of the IEA would be prohibitively costly.

The results of OLABS and LABORS have been given to the governments of Canada and of Newfoundland and Labrador. Environmental information collected aboard drillships is available from federal and provincial agencies regulating offshore exploration, from the Atmospheric Environment Service (AES) or the Marine Environment Data Service (MEDS). However, some data are proprietary for a minimum of two years: these include well logs and the results of production testing, and certain types of physical environmental data collected under the LABORS program, which can be used in engineering design.

1.4 Accuracy, Completeness and Currency of Information

There are four major sources of comment on this topic: 1) the proceedings of the review seminar itself; 2) written comments by the Department of Fisheries and Oceans and the Bedford Institute of Oceanography which were compiled shortly before the review seminar was held; 3) written comments by Environment Canada, compiled three months after the review seminar was held; 4) written comment by COGLA, prepared in autumn 1981 and incorporated into the final draft of the IEA.

Participants at the review seminar appeared to feel that the IEA was uneven in its presentation of baseline information - some sections were judged accurate and well written, other sections were felt to have too much unnecessary information, still others were felt to be deficient.

Occasionally, the seminar neglected to distinguish between deficiencies in existing knowledge and deficiencies arising from a failure of the IEA to quote significant published sources. In a few instances, the IEA was criticized for ignoring published sources that have dubious scientific merit. Participants criticized the IEA's failure to tap unanalyzed government files, or to obtain personal communications from government scientists on certain topics where no published information exists.

Offshore Labrador is remote, and has only sporadically been the subject of scientific investigation until very recently. It is tempting to believe that every scrap of literature will provide a useful insight into the Labrador marine environment. However, uncritical acceptance of anecdotal, unanalyzed raw data and heavy reliance on personal communications would not have contributed to the credibility of the IEA.

It is interesting to contrast the review seminar's evaluations of the descriptions of the physical environment against its evaluations of the biological descriptions. With the exception of geotechnics, the discussions of the physical environment were generally warmly praised for their thoroughness, while the biological sections were heavily criticized. It is true that there was a preponderance of biologists at the review seminar, but there was a good representation of physical scientists also.

A fundamental difference between the physical and biological sections is that the physical sections are summaries of active, on-going research programs that are being carried out in-house by Petro-Canada, while the biological sections are essentially literature reviews compiled by consulting firms. Wherever possible, Petro-Canada incorporated the results of OLABS work into the basic framework of the

biological literature reviews that the consultants provided. However, even with the large amount of new information that OLABS added, there is still no comprehensive picture of the biological resources of offshore Labrador.

Verifying the accuracy and completeness of literature reviews will be a continuing problem for petroleum operators undertaking environmental assessments. This will especially be a problem when the literature is vast and reported in several languages, as in the case for the east coast fishery.

It is clear that a complete review by government scientists of the Offshore Labrador IEA should have taken place before the document was printed, not afterward.

Learning from the Labrador experience, Petro-Canada has asked for a full scientific review of a draft IEE for west coast drilling, now in preparation. The reviewers are working scientists in the regions, representing IOS, DFO, DOE, and B.C. Environment, and are the authoritative specialists in their respective fields. To date, the review process has been most helpful, because the reviewers are committed to ensuring that the document, when published, will be as complete and accurate as possible. Also, the adversarial atmosphere that normally attends governmental review of industry documents has been avoided.

1.5 Summary of the IEA Review Consensus Comments

The following pages summarize the consensus of review comment on the IEA, and on the suggested actions that Petro-Canada could take in future assessment documents.

1.5.1 Section 1 - Executive Summary

This section was judged to be poorly written, although it is not clear from the seminar proceedings what the problem was.

L. Coady of DFO provided a more useful written critique of the Executive Summary (see DFO comments, Section III). He believed that, while the summary was a relatively accurate précis of the IEA, the summary did not emphasize the biological characteristics that make the Labrador Offshore unique, nor did it highlight sufficiently the special technological problems that could affect the environmental safety of exploratory drilling. Written comment by Environment Canada also suggests that problems with well control and environmental safety were downplayed in the Executive Summary. Environment Canada comments note that the IEA fails to recognize that seabirds are inherently more vulnerable than any other group of organisms to oil spills.

The substance of comment concerning the Executive Summary is that the reviewers wanted greater emphasis of the major environmental issues, and wanted these issues to be sharply defined. A corollary is that lesser issues could be treated with less emphasis, or ignored in the Executive Summary.

The Executive Summary is presently being re-written with these guidelines in mind.

1.5.2 Section 2 - Declaration and Need

This section was virtually ignored during the workshop proceedings. Environment Canada provided brief written comments on this section, but the comments were minor.

1.5.3 Section 3 - Offshore Labrador Exploratory Drilling

There were no specific comments on this section during the scientific review seminar. Environment Canada provided a few brief written comments on this section. Environment Canada questioned the superiority of the semi-submersible over the drillship in rough weather, alluding to the Ocean Ranger disaster. It also wished to see an elaboration of relief well drilling procedures and an indication of the time required to drill a relief well.

Despite the Ocean Ranger experience, semi-submersibles are superior to drillships for drilling in high sea states. However, the inquiry into the Ocean Ranger's sinking may recommend modifications in operating procedures. Except as stated in the text of the IEA, relief well drilling is similar to routine exploratory drilling; there is no additional information on the time it would take to drill a relief well under Labrador conditions.

1.5.4 Section 4 - Planning and Design of Offshore Production Systems

There was no substantive comment on this section during the scientific review seminar. Because much more conceptual design would be necessary to develop a production system in the pack-ice and iceberg-infested environment off Labrador, the conclusions of this section are extremely tentative.

Environment Canada provided brief written comments on this section. It requested more information on LABORS. At the time the IEA was being written, engineering information used in the LABORS project was proprietary and confidential, although supporting environmental data were available. Environment Canada commented that two of the four alternative production systems seemed impractical to them.

The whole point of LABORS is to evaluate all alternatives and develop the concepts that seem most feasible. It would thus have been inappropriate for the IEA to evaluate any of the alternatives.

1.5.5 Physical and Biological Environment

Section 5.1 Geology and Physiography

Generally, this section was felt to be accurate and complete. However, the discussion of onshore bedrock geology and onshore physiography was felt to have little relevance to offshore hydrocarbon exploration. The seminar felt that this irrelevant material should have been left out of the IEA.

Petro-Canada accepts this comment, and will delete treatments of onshore information in similar documents.

Section 5.2 Coastlines

Generally, this section of the document was highly praised for its accuracy, completeness and organization.

There was a great deal of interest in an OLABS project to map coastal information, and to store this cartographic information in an interactive computer program. Many seminar participants wanted to see the results of this project (which was begun in 1981) incorporated into a revised IEA. As pointed out earlier, there will be no revised IEA, but the results of recent coastal mapping will be available as an OLABS report when the project is completed.

There appeared to be much inconclusive discussion of whether the technology existed to clean up an oil spill in the nearshore zone, and of the value of ranking coastal areas by sensitivity. No firm consensus seems to have arisen from these discussions.

Section 5.3 Geotechnical Hazards to Offshore Drilling and Production

This section was almost universally criticized by the seminar participants as one of the weakest sections of the IEA. This section lacked the scholarship evident in the discussions of geology, physiography and coastlines. The discussion of the effects of each of the geotechnical hazards on exploration and production operations was too generalized to be useful. The IEA did not make use of recent work done by C-CORE, Ocean Engineering and NICOS. Data on earthquakes are based on work done in the 1960's.

Although costly to obtain, the geotechnical data from site surveys (quoted in Section 5.3.2) are generalized and inconclusive.

Petro-Canada accepts these criticisms. Much more geotechnical work will have to be undertaken if hydrocarbon production takes place on the Labrador Shelf. For the purposes of exploratory drilling, the limited site surveys are adequate to determine whether it is safe to drill at a particular prospect. However, the site surveys do little to give a regional understanding of the geotechnics of the Labrador Shelf as a whole.

Section 5.4 Sea Ice and Icebergs

This section was generally warmly praised by the seminar participants. Realizing that LABORS includes an active ice studies program, the participants wished to see the most recent results incorporated into a revised IEA. As already noted, there will be no revised IEA. A further complication is that ice and iceberg studies conducted under the LABORS program are proprietary, and are thus not readily available to the public. Scientists wishing to obtain LABORS data should contact the chairman of the Labrador Group of Companies, specifying exactly which data they would like to obtain. The chairman will then ask the Labrador Group's concurrence in releasing the data. Release of these proprietary data is not automatically assured.

Seminar participants noted that much of the iceberg data were collected from the banks, but that there was little information from the troughs and saddles. Seminar participants recommended that more research be done on processes within the zone of shorefast ice. It is unlikely, however, that industry will undertake this work, because exploration is proceeding only within the zone of winter pack ice. Thus, studies of shorefast ice phenomena would have little relevance to engineering design. The seaward edge of shorefast ice would be a barrier to the onshore movement of oil from a blowout, so that shorefast ice would not likely be extensively contaminated by oil. Finally, extensive work on shorefast ice is being done in the Beaufort Sea.

Environment Canada provided extensive written comment on this section. Petro-Canada's responses to specific comments appear in bold type immediately below the written comments.

Section 5.5 Climatology

The workshop response to this section was mixed, although no serious deficiencies were pointed out. One participant suggested that atmospheric pressure patterns were treated statically, where a more dynamic treatment that invoked a discussion of storm tracks might have been more useful. There was inconclusive discussion of the adequacy of existing meteorological reporting systems. There appears to be a serious day-to-day operational problem because AES is

not relaying weather data to industry rapidly enough. The seminar recommended research to obtain better data on superstructural icing, and analysis of existing data collected aboard Zapata Ugland on the Grand Banks.

AES provided detailed written comment in the Environment Canada critique. Petro-Canada responses appear in bold type immediately below the written comments.

Section 5.6 Physical Oceanography

This section was praised for its completeness, accuracy and thoroughness by the seminar participants. However, the participants were aware of the extensive oceanographic program of 1980 and 1981, and wished to see these new data incorporated in a revised IEA. Though a revised IEA will not be printed, data from ongoing oceanographic programs will be available from several sources. Waverider and current meter data required by COGLA under drilling program approvals are freely available from that source. Oceanographic data collected under the auspices of OLABS are available upon request from Petro-Canada. Oceanographic information collected under the LABORS program is the property of the Labrador Group of Companies, and must be requested formally by the same mechanism as for ice information.

The seminar participants believed that water properties and currents are a major driving force for many of the phenomena described in other disciplinary treatments. More specifically, a detailed understanding of ocean currents is necessary to understand such disparate phenomena as sediment transport, oil slick movements, seabird distributions, nutrient availability, and ichthyoplankton drift. The seminar participants wished to see more work done on ocean currents over the continental slope, which appears to be an area of complex circulation that has great biological significance.

The lack of winter information on physical oceanographic parameters was felt to be a deficiency. However, industry is unlikely to collect this information so long as exploratory drilling is limited to the ice-free period of summer and early autumn.

The seminar participants wished to see more work done on phenomena affecting the transport of oil near shore. There are no industry plans for such work at present, although BIOS results may be useful.

AES provided detailed comments on this section in Environment Canada's written critique. Petro-Canada's responses appear in bold type immediately below the written comments.

Section 5.7 Chemical Oceanography

The seminar consensus was that this section adequately reflected the scanty information available. However, the data base is presently far from adequate.

It was noted that there is some unanalyzed information on chemical oceanography in the MEDS files, but this information has not been published. Some participants felt that Petro-Canada should have analyzed and presented this information in the IEA. Petro-Canada was simply not aware that the information existed, and it hopes that government will soon analyze and publish these data.

DFO provided brief comment on this section. The weaknesses that DFO refers to are deficiencies inherent in the design of the OLABS studies, not in the way the IEA quoted them. DFO would have liked to have seen the OLABS studies extend over the continental rise, where there could be an area of significant nutrient exchange.

Section 5.8 Microbiota

The consensus was that there was surprisingly little information in the literature on the microbiota of the Labrador Sea, and that this lack was reflected in the IEA.

In response to written DFO comment, the IEA was an accurate paraphrase of Bunch (1979).

Section 5.9 Primary Producers

This section had a mixed reception by the review seminar, primarily because the existing literature is itself of uneven quality. There is no information on the epontic community of the Labrador coast, nor on the relative contribution of the epontic flora, macrophytes, and phytoplankton to primary productivity. Information on primary productivity is itself poor for the Labrador offshore; the most comprehensive information is from the OLABS studies, which presented results in terms of standing crop biomass, not productivity.

Two serious but incorrect criticisms of the IEA were made during the review seminar: one was that the work of Barrie et al. (1980) had not been extensively quoted (it had); the second was that LGL had been misquoted (the alleged misquote is an accurate paraphrase of page 93 of Buchanan and Foy, 1980).

Responses to DFO and Environment Canada's comments appear in bold type immediately below the written comments. Most comments deal with the interpretation of an inconsistent data base.

Section 5.10 Zooplankton

There was little substantive comment on this section during the review seminar. At the time the IEA was being written, the OLABS zooplankton studies had not been completed. Written comment by DFO notes the lack of information on biomass (as opposed to numbers of individuals) and on seasonal variations in zooplankton abundance. Recent OLABS work (Buchanan and Browne 1981) provides information on zooplankton biomass, but no information on productivity or seasonal abundance.

Responses to DFO and Environment Canada's comments appear in bold type immediately below the written comments.

Section 5.11 Benthos

There was no substantive comment on this section during the review seminar. DFO provided many written revisions to the discussion of economic shellfish; these revisions would have added greatly to the precision of the IEA.

The review seminar admired the biophysical approach of Barrie *et al*. (1980) in describing the distribution of benthic communities. Most participants agreed that this approach should be extended to other nearshore areas, and that the approach should also be used for deep-water communities.

Section 5.12 Ichthyoplankton

The deficiencies identified by the review seminar and in the written comment of DFO are deficiencies in the literature. The review seminar agreed that much more research on ichthyoplankton distributions (both horizontally and vertically) is needed, and that critical spawning areas for fish with demersal eggs should be more precisely defined. OLABS examined ichthyoplankton distributions during July through September only, consequently there is incomplete information on fishes that spawn during the winter and spring. OLABS did not sample ichthyoplankton over the continental slope.

Section 5.13 Marine and Anadromous Fish

Section 5.14 The Labrador Commercial Fishery

The consensus of the review seminar was that this section was not complete or accurate. The written DFO commentary suggests many minor corrections.

During the review seminar, comment on the completeness and accuracy of this section was contradictory. For example, in session B, Group III stated that "little time was

available to discuss fisheries". DFO and group comments indicated it was a good section. However, in the closing plenary session, Group III contradicted this statement, reporting that "The information on fish stocks wasn't comprehensive or adequate." Self-contradictory evaluations appear also in DFO's and COGLA's written comment contrasted to oral comments made during the review seminar.

Petro-Canada is concerned that the review seminar felt that fifty pages of text, summarizing the results of approximately 200 publications, still did not contain enough information to adequately describe the Labrador fishes and the fishery.

The major sources of these perceived deficiencies appeared to be:

- reliance on published literature, primarily JFRB and its associated bulletins and monographs;
- failure to tap the so-called "grey" literature in CAFSAC and NAFO research documents;
- failure to seek personal communications from specialists in particular areas;
- failure to quote sources later than 1979.

The last source of deficiency was inevitable, because the source document for these sections was written in 1980, and the compilation of the IEA began shortly thereafter. The other sources of deficiency led to the controversy of whether it is scientifically valid to rely heavily on personal communication and unrefereed documents with limited circulation. Because these sources of information have not been subjected to rigorous peer review, the conclusions to be drawn from them must be tentative.

It would have been useful, however, to have asked DFO to review these sections before the IEA went to print.

Section 5.15 Seabirds and Waterfowl

This section was heavily criticized in the review seminar and in written commentary by CWS. The review seminar incorrectly believed that recent OLABS data had not been quoted. In fact, results of all 1979 and 1980 surveys were included. LGL has still not reported the results of its 1981 or 1982 work.

The most useful critique of this section is the written commentary by Dr. Brown of CWS. The thrust of his comment is that the IEA relies too heavily on secondary sources (consultants' reports, Godfrey 1966, Bellrose 1976). Much of Dr. Brown's comment is based on his personal knowledge of both the literature and unpublished information.

The IEA would have benefitted greatly by his vetting of Section 5.15 before the document went to press.

Section 5.16 Marine Mammals

This section was heavily criticized by DFO, although the critique was somewhat lacking in rigour. Although DFO was "not impressed" with the sections on marine mammals, particularly whales, DFO did not specifically state what the deficiencies regarding whales were, or list pertinent authorities who should have been cited aside from an obscure allusion to "recent CETAP work."

The seminar participants believed that the controversy over the seal hunt has stimulated research into harp and hooded seals. Rather little of this information has been published in refereed journals, although DFO indicated that CAFSAC documents may contain some information. Except for recent OLABS work, there have been relatively few useful studies of the numbers, distribution, migrations or ecology of marine mammals in Labrador, and this is reflected in the IEA.

1.5.6 Interpretation of Baseline Data for an Environmental Assessment

This section summarizes the review seminar's appraisal of Section 6 (Environmental Impacts and Mitigating Measures) and Section 7 (An Overview of Social Conditions in Labrador). It also responds in a general way to written review comments from Environment Canada, DFO, and BIO.

During the review seminar, there was sometimes a blurring of the important distinction between the factual content of the IEA, and the way the data had been interpreted in forming an environmental assessment. More bluntly, it was not always easy to separate verifiable fact from opinion.

Further, it is clear that both these sections generated a great deal of debate within groups, to the point where group chairmen were unable to report a consensus on particular issues.

Perhaps the lack of consensus in the review seminar reflects the lack of commonly held criteria and guidelines for what an impact assessment should contain. In the absence of such criteria, there is no way to interpret whether an environmental assessment has met the objective desired by government, and review of such documents becomes an obscure form of literary criticism.

Environmental Impacts and Mitigating Measures

The review seminar did not give Section 6 of the IEA the same thoroughness of review that was given to the baseline descriptions in Section 5. Long and important elements of Section 6 were barely touched upon. Examples are:

- Section 6.1 - which discusses the assumptions implicit in the entire section;
- Section 6.3 - contributions of oil blowouts to oceanic pollution;
- Section 6.4 - analysis of risk of blowouts;
- Section 6.5 - fate of oil and gas following blowouts;
- Section 6.6 - effect of spills on the physical environment;

It is clear that the review seminar evaluated the accuracy of the baseline information primarily in the context of a blowout scenario. However, the seminar was never able to focus clearly on the scenario itself.

The review seminar concentrated discussion on these major issues:

- the applicability of laboratory studies of acute and sublethal toxicity to the natural situation;
- the effect of drilling mud disposal on marine organisms;
- the validity of the elaborate blowout scenarios presented in Section 6.8.

Applicability of Laboratory Studies to the Labrador Shelf

The major comment on the applicability of laboratory studies came from one of the resource persons. Much of the information on acute and sublethal toxicity of oil to marine life is derived from laboratory studies, but these studies can only approximate what would happen during an oil spill in the wild. For example, experimental conditions in the laboratory are held relatively constant, while in nature, conditions such as temperature, salinity, currents and light may vary greatly during short periods. Experimental organisms are held captive, and cannot move to escape from stressful stimuli. Social responses in laboratory situations may be quite different from those in the wild. Synergistic effects of environmental stresses are ignored.

Microcosm experiments and experimental oil spill studies such as BIOS could, it was agreed, provide more realistic simulations of the effects of an oil spill in natural situations.

One group wondered whether the effects of oil on marine life should have been reviewed in the IEA. It concluded that, without such a treatment, the IEA would simply be a literature review.

Disposal of Drilling Muds

The consensus of the review seminar agreed with a major conclusion of the IEA; that drilling mud disposal from exploratory drilling would cause localized, but environmentally acceptable perturbations to the marine life of the Labrador Shelf. Acute toxicity of drilling muds seemed not to be a great concern to seminar participants, because the most recent literature confirms that toxicants in drilling fluids are rapidly diluted to concentrations below the threshold of acute toxicity.

However, there was considerable concern about the potential for chronic pollution by heavy metals in drilling muds. Chromium is the heavy metal of greatest concern. Ferrochrome lignosulphonate is used in substantial quantities in mud systems, and considerable amounts of chromium could enter the sea through mud dumping. There is also a concern that some sources of barite, such as those from Buchans, Newfoundland, have high concentrations of arsenic, cadmium, mercury and other heavy metals. Because barite is a major component of drilling mud systems, mud dumping could cause elevated concentrations of these heavy metals in Offshore Labrador waters.

Sustained monitoring of heavy metals concentrations off Labrador was a major recommendation of the review seminar.

Validity of Oil Spill Scenario

There was considerable heated discussion of Section 6.8 of the IEA, which discussed the probable behaviour and effects of oil released by a well blowout on the Labrador Shelf.

Some participants mistakenly believed that the oil spill scenario was quantitative, and that the scenario was derived from numerical information. In fact, the scenario was derived from inferences based on what is known of generation times, fecundity, relative abundance and behaviour of marine organisms. The impact ratings (slight/moderate/severe) applied to the various groups of organisms are thus qualitative. They are a first-approximation estimate of the time required for various groups of organisms to recover to prespill numbers after an oil blowout occurred.

Dr. Brown of CWS felt that the ratings applied to certain groups of seabirds were inaccurate, and offered a revised scheme of rankings.

There was considerable discussion of whether the spill scenario should have included even the qualitative ratings offered in Section 6.8, because good quantitative information is lacking for offshore Labrador. Tentatively, the review seminar found this approach a useful first approximation, although the ratings of impacts on some organisms would have to be heavily qualified. Some participants felt that, without a synthesis such as the scenario of Section 6.8, the IEA would have been simply a literature review.

Summary Remarks - Environmental Impacts

It is disappointing that the review seminar came to no firm conclusions about the kinds of information an analysis of impact should present, or the way this information should be interpreted to identify the key environmental concerns. The seminar proceedings indicate a vague, inarticulate dissatisfaction with the analysis of impact, but the commentary is of little assistance in writing similar analyses for other documents. However, some implicit guidelines can perhaps be drawn from the interest that seminar participants showed in the discussion of the baseline data.

There was lively interest in the interactive computer program that will store, manipulate and display coastal information for contingency planning purposes. Some workshop participants suggested that the results of this program should have been included in the IEA; however, development of this program is still in progress and results are still unavailable. Nonetheless, these comments suggest that a cartographic approach, with mapping of sensitive areas by season, would have been welcome in Section 6.

The review seminar almost universally recognized that oceanographic, geological, and sea ice processes are driving forces that determine the pattern, intensity, and timing of biological events in the Labrador Sea. This suggests that a biophysical approach to organizing environmental information would have been useful in the analysis of impact. Although this was never well articulated, it appeared that seminar participants would have preferred an assessment of the effects of hydrocarbon exploration on ecosystems, not on organisms.

The interest of the seminar in an ecological rather than a physiological evaluation of the effects of oil on marine life is reflected in the interest in "indicators" of "ecosystem health" suggested by Drs. Addison and Williams.

Unfortunately, there is presently no comprehensive analysis of the marine ecology of the Labrador Shelf. No one has yet provided a unified discussion of the interrelationships among ocean currents, sea ice dynamics, nutrient distributions, energy fluxes through interacting, seasonally changing food webs and coastal processes. Thus, a truly ecological evaluation of the effects of hydrocarbon exploration on the marine life of the Offshore Labrador Shelf has yet to be developed. For all its flaws, the Labrador IEA is the first document that assembles enough of the information required for such an analysis to begin.

Overview of Social Conditions in Labrador

During the review seminar, discussion of this section also generated much heat, but little light. Three fundamental issues pervaded these discussions:

- the ability and responsibility of natural scientists to comment upon the social sciences;
- the relative merits of presenting socioeconomic data in an intuitive, humanistic framework versus a factual, statistical analysis;
- the responsibility of an oil company to present data that could be construed as a criticism of local people.

A disappointing element of the review seminar was that the participants representing Labrador public interest groups (LRAC, LIA) withheld comment on Section 7, pending a workshop to be held in November 1982. Thus, the very people who were best able to comment on this section said little.

Some of the natural scientists attending the review seminar felt that their training did not equip them to speak cogently about socioeconomic issues. However, the consensus appeared to be that science and technology could profoundly affect the lives of Labradorians, that scientists and technologists had a responsibility to understand the implications of their work on local people, and that they had a responsibility to address human issues.

The review seminar was divided on the issue of presentation of socioeconomic data. Section 7 of the IEA was based on an overview prepared by Dr. A. Williamson of Memorial University, a researcher with long experience in Labrador. Unlike many socioeconomic analyses, Section 7 was written in a discursive, almost "folksy" style that most reviewers found lively and readable. The treatment of social conditions emphasized Labradorians' dependence on a seasonally shifting, pluralistic economy that exploited a wide variety of marine and terrestrial resources at different seasons of the year. Unlike most socioeconomic analyses, Section 7

of the IEA presented very little statistical or demographic information such as age structure, ethnic origin, employment in the public or private sector, or level of education.

Many review seminar participants were uneasy with the purely descriptive approach used in the IEA. They recommended a more statistical, formal presentation of information, although they had no specific suggestions on the kinds of information they wanted. It was recommended that there be a survey of social attitudes to oil exploration, and a survey of cash equivalence of country foods and other natural resources used in the subsistence economy.

There was no discussion of whether a more formal, statistical, socioeconomic analysis would be acceptable to the people of Labrador.

The third major element of discussion in the socioeconomic review was the discussion of sociomedical problems in Labrador. In some communities, there is a high incidence of communicable diseases, illiteracy, alcohol abuse, and other sociomedical problems. Petro-Canada deliberately chose not to emphasize these problems in the IEA, because they could be construed as a southern outsider's criticism of the local people. The company felt that it did not induce these problems, nor has it aggravated them. However, the review seminar felt that sociomedical problems should have been addressed, and that failure to do so constitutes a deficiency in the IEA. Failure to discuss sociomedical problems represented, to some seminar participants, an attempt to present a "prettified" picture of Labradorian life. Further, it was felt that petroleum exploration could, in some ways, be part of a solution to these problems.

Group III put forth one comment that must be challenged: "The document makes suggestions as to how Labradorians wish to chart their future. It should be up to Labradorians to let their needs be known, and yet there has been a lack of input from these people." The statement that the document is attempting to dictate the way Labradorians wish to run their lives is incorrect - the document pointedly avoids doing so. The second comment of lack of public consultation is also incorrect. The prime source of the overview is a researcher with over twenty years' experience in Labrador. Also, the St. John's scientific review seminar and the public review scheduled for Goose Bay in November 1982 are evidence that the wishes of Labradorians are indeed being canvassed.

1.5.7 Recommendations for Further Research

During the course of the review seminar, long lists of additional studies were suggested. Some of these studies

accord well with the industry objectives set forward in Section 8 of the Labrador IEA:

1. to improve engineering design of equipment used in ongoing exploration and in future production systems;

2. to improve oil spill response;

3. to improve monitoring systems, both for short-term major impacts (spills, blowouts) and for long-term chronic pollution.

As noted in the IEA, the petroleum industry gives low priority to funding studies that do not relate clearly to these objectives.

During the review seminar, there was not always a clear separation of the responsibilities of government agencies, the petroleum industry, and the commercial fishing industry in undertaking research. Occasionally, it was recommended that the petroleum industry perform certain studies that more clearly were the mandate of government, but which government was unable to fund because of fiscal restraint.

The studies recommended by the review seminar were too numerous to evaluate separately here. However, a brief summary of research recommendations could be useful in designing government, industry, and co-operative research strategies.

Studies Related to Engineering Design

These studies have been an industry priority, and industry is likely to be the major funding and expediting agency. Industry's commitment to do Offshore Labrador research will likely be affected by the success of exploratory drilling programs now in progress. If the likelihood of discovering and developing economically exploitable reserves of oil or natural gas appeared remote, it is unlikely that industry would continue to fund studies related to the design of production systems.

Agencies such as NICOS AND C-CORE also participate in research related to ocean engineering off Labrador.

Ice Studies

Section 8.6 of the IEA and John Miller's proposals for ongoing research outlined the petroleum industry's plans for sea ice and iceberg research. The review seminar indicated that ice studies were well designed. The seminar was concerned that not enough is known for the engineering design of year-round production systems at present, that iceberg

trajectory modelling be improved and that indices of iceberg occurrence frequency be refined. Because they were concerned with a possible extension of the exploratory drilling season into late autumn, participants recommended more studies on freeze-up and pan ice formation.

Oceanographic Studies

Section 8.6 of the IEA and Joe Buckley's remarks at the review seminar outlined industry's proposals for oceanographic studies to support engineering design. The review seminar generally praised the physical oceanographic research that has been done to date. The only recommendations relating to engineering design are that the information base on sea state be expanded and standardized, particularly for the late fall, and that the influence of ocean currents on iceberg trajectories be studied in more detail. Although costly to mount, a winter program of physical oceanographic studies may be useful for understanding sea ice dynamics.

Meteorological Studies

Section 8.6 of the IEA and Bill Thompson's remarks during the workshops indicate industry's proposals for meteorological research. The review seminar recommended the following general ways to improve meteorological information. A closer integration of AES and MEDS would ensure timely circulation of data and avoid duplicted effort. A quicker turn-around time for the relaying of AES data to the operator would improve weather forecasting. Industry should devote more attention to the problem of ice accretion on rig superstructures. The density of offshore weather reporting stations should be increased. Petro-Canada's 1982 meteorological program in support of drilling operations has, in fact, included more automated offshore stations than previously.

Geotechnical Studies

The review seminar had strong reservations about whether there was sufficient information on geotechnics, because of the limited applicability of the site surveys, which are done in a relatively small area surrounding each prospective new well. Although these site surveys may be adequate for exploratory drilling from floating platforms, the review seminar felt that there was not enough information to install bottom-founded production systems or pipelines. The review seminar recommended closer liaison between industry and researchers at C-CORE, NICOS, and Ocean Engineering (MUN). The distribution of seafloor sediments and the geographic distribution of iceberg scouring were the most pressing research priorities identified by the seminar.

Studies Related to Improved Oil Spill Response

The review seminar identified a vast spectrum of studies that could loosely be said to relate to improved oil spill response. However, the repertory of existing countermeasures for the Labrador Shelf is very limited:

- surveillance and monitoring (do nothing, but follow the movement of a slick)
- chemical dispersion
- mechanical containment and cleanup of floating oil
- subsea containment of oil above the wellhead
- *in-situ* combustion of oil trapped in sea ice
- mechanical cleanup of oiled beach sediments, with combustion of stranded oil
- treatment of oil with sorbents, coagulants, and sinkants

When an oil spill actually occurs, the basic use of environmental information is to help decide whether, where, when, and how to apply any or all of these countermeasures.

Industry has found it difficult to see the direct application of sophisticated ecological studies to the basic decisions affecting the choice and application of countermeasures. Thus, associations such as the Canadian Offshore Oil Spill Research Association (COOSRA) spend more money on developing countermeasure techniques than on understanding ecological processes. A similar technological bias occurs in the two government agencies directly concerned with offshore countermeasures - the Environmental Protection Service and the Canadian Coast Guard.

Pragmatically, on-scene commanders do not use complicated ecological information when they organize an oil spill response. The basic environmental information needed for oil spill response is:

- a ranking of the relative vulnerability of the biota to oil at the time the spill is taking place
- the location of sensitive concentrations of marine life
- the location of sensitive areas of human activity
- the present location of the spilled oil

- the physical and chemical state of the oil

- a forecast, in real time, of where the oil is likely to go

- a forecast of weather conditions that might affect the weathering of oil and the applicability and feasibility of countermeasures

- a ranking of areas where countermeasures are likely to be effective.

While this listing is simplified, it does indicate that the information actually required for oil spill response is far less complex than biological scientists assume. Information on energy fluxes in food webs, competitive relationships, or stock recruitment will have little bearing on whether or not, for example, dispersants are used. In short, many of the studies recommended by the review seminar would produce information that is "nice to know", but of little use in a real environmental emergency.

Nevertheless, the review seminar did make some research recommendations that may greatly improve contingency planning. They are summarized in the following paragraphs.

Identification and Ranking of Sensitive Areas

It is convenient to divide sensitivity mapping into coastal and offshore categories. Features considered in coastal sensitivity mapping tend to be relatively static in location over a period of years or decades. These include shoreline texture, wave energy and fetch, shoreline vegetation, bird colonies, traditional fishing areas, settlements and estuaries of salmon spawning streams. These relatively static and predictable features are relatively easy to map.

By contrast, the sensitivity of offshore areas appears to be influenced by more dynamic processes that may vary considerably during a period of a few days or weeks. A partial list of these processes includes: upwelling, surface currents, sea ice conditions, temperature and salinity gradients, location of prey concentrations and migratory behaviour. Because these determinants of sensitivity are dynamic, they do not lend themselves readily to sensitivity mapping.

The review seminar supported the interactive computer program for storing and manipulating information on coastal geomorphology. The seminar recommended that the scope of the program be expanded to include biological data and information on the human use of nearshore resources. Sensitivity mapping should be extended into the Strait of Belle Isle and Hudson Strait.

Although not explicitly stated, many of the research recommendations dealt with identifying and ranking sensitive offshore areas. The review seminar universally accepted the notion that physical oceanographic and ice processes are primary determinants of biological processes. The review seminar strongly urged research into the relationships among physical processes and nutrient, plankton, fish, seabird and marine mammal distributions. Such information would ultimately lead to a better ability to predict the location of sensitive offshore areas at critical periods of the year (e.g. seal whelping, seabird chick-rearing, cod spawning, migration).

The existing literature contains little information on critical areas for marine life during the winter season. Although exploratory drilling ceases in autumn, the review seminar was concerned about the possibility that a late-season blowout might not be controlled by a relief well until the following spring. A general recommendation was that more information be gathered on winter distributions of seabirds and marine mammals. Unfortunately, this information would not be especially useful for contingency planning, because oil entrapped in sea ice cannot be effectively cleaned up until the ice begins to melt in spring, by which time oil-contaminated pack ice may have moved a considerable distance from the blowout site. Thus, although winter studies would provide detailed information on the magnitude of environmental impact, nothing practical could be done with this information to mitigate the impact of an uncontrolled late season blowout. Existing countermeasures technology is simply too limited.

The review seminar also recommended further research into the effects of oil on the epontic (under ice) community of Labrador, and into the proportional contribution of epontic algae, the phytoplankton and macrophytes to total productivity. Similar work is being done in the BIOS program, and results will probably be applicable to Labrador. Although this research might be interesting, it has no practical application to the design of an oil spill response strategy, because of the limitations of existing technology.

The review seminar made a general recommendation that computerized, mathematical scenario models be developed for assessing the impact of routine production operations and of environmental emergencies. The seminar recommended that ecological, economic, operational and mitigative factors be considered. COOSRA is already supporting the development of spill scenario modelling of this sort, although these models are still at a rudimentary stage. If such models eventually become able to make predictions in real time, they will be a powerful tool for helping on-scene commanders to decide how, when, and where to deploy equipment and manpower during a spill.

Studies Recommended for Improved Monitoring

Generally, the purpose of monitoring studies is to detect and measure man-induced changes in the environment, and to recommend courses of action to minimize reductions in the diversity, productivity, or standing stock of marine life. A problem with monitoring in a varying environment such as offshore Labrador is the difficulty in separating man-induced changes from natural variations due to changes in climate, mass transport of oceanic currents, or the invasion of new species of pathogens, predators and competitors. A further problem is distinguishing the changes caused by one class of human activity (e.g. petroleum exploration or production) from others (e.g. fishing, hunting, or stream impoundment).

The review seminar agreed with many recommendations for monitoring made in the Offshore Labrador IEA, and suggested other monitoring studies as well. The review seminar did not clearly articulate which types of monitoring studies should be undertaken by industry, and which by government. There appeared to be considerable support for co-operative research supported by both sectors, and for the concept of integrated studies set forth in the IEA.

The IEA recommended monitoring studies to establish baseline heavy metal and hydrocarbon concentrations in water and in seafloor sediments of the Labrador Shelf. This recommendation was supported in the review seminar. Some participants noted that the chronic sub-lethal toxicity of heavy metals (notably chromium) released from drilling muds could well be more significant environmentally than the effects of a blowout. Benthic organisms, perhaps scallops, were suggested indicator organisms. It was also recommended that drilling muds be monitored for radioactivity.

A wide variety of studies were suggested to monitor the changes that could result from a natural gas or oil blowout. Possible indices of "ecosystem health" were suggested:

- phytoplankton standing crop, interpreted by Landsat imagery;
- the concentrations of mixed-function oxidases, which are indicators of generalized stress in organisms;
- fatty acid concentrations.

A problem with some of the suggested monitoring studies is repeatability. It is unlikely that industry will fund multi-year studies of ecological processes purely for monitoring purposes, because it would be excessively costly to repeat such long-term studies periodically. It is more likely that a few indicator organisms would be selected for periodic

evaluation. However, there were no suggestions from the seminar as to which indicator species should be selected.

The review seminar strongly urged the collection of sociomedical statistics, as a way of monitoring changes that hydrocarbon exploration may be making to the social fabric of Labrador. While this information might perhaps have been useful to include in the IEA, the responsibility for collecting such information rests primarily with provincial agencies in charge of health and welfare, education, and community planning. It is true that the petroleum industry, acting on the advice of the communities and the provincial government, must act responsibly in its employment practices, the siting of its facilities and in the environmental safety of its operations. However, a point made strongly in the IEA, but missed by some of the seminar participants, is that hydrocarbon exploration is but one of many factors that could affect social change in Labrador.

1.5.8 Guidelines for the Preparation of Assessment Documents

A fundamental source of frustration in the review seminar was the lack of a clear understanding of the purpose of the Offshore Labrador IEA, and the lack of measurable standards to judge whether a document succeeds or fails. Because the IEA was not a decision document, (i.e. its acceptance would not affect whether oil exploration would be allowed to proceed) this absence of measurable objectives was tolerable.

The lack of explicit guidelines for writing assessment documents has encumbered the environmental assessment process in Canada. Industrial proponents are concerned because they must spend large amounts of money collecting information that is "nice to know", but has little, if any, application to project design, compensation schemes, mitigation, or contingency planning. Projects that are necessary to the country's economic growth may be needlessly delayed, because information needs are identified through a time-consuming adversarial review process. Deficiency-listing could be avoided if information needs and sources were to be clearly identified <u>at the beginning</u> of the environmental review process, not at its end. On the government side, regulatory agencies are frustrated because assessment documents never seem to provide enough information for clear "yes/no" decisions to be made, for effective environmental operating conditions to be developed, or for monitoring programs to be implemented. Often, this adversarial review process can lead to cynicism on both sides.

The need for explicit guidelines in preparing environmental documents was raised during the closing plenary

session of the review seminar. Although there was general agreement that government should develop specific guidelines at the beginning of the environmental review process, there were no concrete proposals about the kinds or amount of data that a proponent should be required to supply. There were also no concrete suggestions about how government should make its information requirements known to the proponent, though it was agreed that the present process is unsatisfactory. Disappointingly, the review seminar did not bring the issue of guidelines into clear focus, and the discussion was dropped.

The Pacific and Yukon regions of Environment Canada have recently made a useful suggestion for improving environmental assessment. The suggestion involves "scoping sessions" at regular points in the assessment process. At the beginning of the process, the proponent and government regulators would develop a detailed list of information requirements, with measurable targets for the quality and kind of information that should be presented. There would be explicit instructions upon the way that baseline data should be analyzed and presented. Interpretation of the data would be done in a way that would provide definitive answers to specific questions.

For government regulators, this concept would ensure that assessment information is collected to meet their specific needs, and would also facilitate the design of joint government/industry studies. The proponent has some assurance that the environmental information being collected is acceptable to government, that money will not have been wasted in unnecessary research, and that projects need not be delayed in rectifying data deficiencies that ought to have been clearly identified in the first place.

1.5.9 Purpose and Explanation of the Numbering System to Match Seminar Review Comments with Petro-Canada's Responses

In order to place some further perspective and evaluation on the many comments that were expressed in Group I, II and III discussions and in written reviews by government, Petro-Canada undertook to respond to the points of concern raised. It was necessary to establish a numbering system whereby the numbered seminar review comments could be matched to the corresponding Petro-Canada response. For reasons of clarity, the matching Petro-Canada response has been placed immediately below the seminar comment in bold type. The numbering system commences in Section II with the Group I discussion in Session A and continues through the three written government reviews in Section III.

This endeavor entailed additional study searches to update the information available. It is Petro-Canada's hope

that the results of the scientific review will be made even more meaningful.

Section II

2.0 PROCEEDINGS OF THE SCIENTIFIC REVIEW SEMINAR

2.1 Introduction

Oil and gas exploration has been ongoing since 1971 in the Labrador offshore. Since 1980 Petro-Canada Inc. has functioned as operator for the Labrador Group of Companies, the holder of the largest block of leases in the area.

In recognition of the need for environmental information in its area of operations, Petro-Canada produced a document in January 1982 entitled - Offshore Labrador, Initial Environmental Assessment (IEA). As noted in the Letter of Transmittal for the document:

> "This Initial Environmental Assessment will be circulated widely within the petroleum industry, within agencies of the Government of Canada and of Newfoundland and Labrador, and among members of the concerned public. It is hoped that this IEA will help clarify, and perhaps resolve, the environmental concerns raised by offshore hydrocarbon exploration in Labrador. Comments on the material contained in this Initial Environmental Assessment will be welcomed".

In an effort to facilitate the review and appraisal of this document, Petro-Canada retained LeDrew Environmental Management (LEM) Limited to organize a scientific review seminar. The seminar was held at the Lester Hotel, St. John's, Newfoundland, May 18-19, 1982.

The stated purpose of the seminar was to review and evaluate the IEA document and to identify and priority rate further necessary studies.

A group of approximately thirty scientists and managers were invited from government and universities. This was augmented by eleven resource persons from Petro-Canada and its consultants. The participant list was developed through consultation with involved agencies and was aimed at inclusion of scientists interested in or active in Labrador offshore.

Following an Opening Plenary Session, the participants were divided into three heterogenous groups. Each group reviewed the IEA in a three-session exercise. During each session a specific group of resource persons was available to outline work in the IEA, describe further work underway or completed since IEA release and encourage discussion. Appendix 1 of the IEA document contains the agenda for the seminar, a description of the area covered by each session, and a list of participants.

The sessions proceeded concurrently with each workshop group tackling a different session at the same time. The staggering was intended to allow the same resource persons to work with each workshop group. Each of the three sessions lasted three hours, so a total of nine hours was allowed for detailed review of the document by each workshop.

Following the completion of the review sessions, a two-hour wrap-up (brainstorming) session was held by each workshop group. At this session the participants tried to relate information deficiencies to potential impact concerns so that a priority listing could be established.

The workshop sessions lasted until mid-afternoon of the second day. Following a break, the Closing Plenary Session was held. Each chairperson reported on the conclusions reached during the brainstorming session. This was followed by a general discussion on the exercise, with closing comments by Dr. W. Speller (Petro-Canada) and B. LeDrew (LEM).

To assist in recording proceedings, each workshop group was assigned a rapporteur who was at the disposal of the chairperson. The notes taken formed the basis of this summary document which serves as the report on the seminar.

2.2 OPENING PLENARY SESSION

2.2.1 Introduction - Dr. S. Wayne Speller, Manager, Impact Assessment (Offshore), Petro-Canada

Two reviews of the Initial Environmental Assessment (IEA) are being conducted, the first of which is the scientific review going on here. The second is to take place this fall in conjunction with the people of Labrador. These reviews are being sponsored by Petro-Canada as the operator for the Labrador Group of Companies. Bevin LeDrew has been responsible for the planning and organization of these sessions.

The concept and idea for the reviews originated with the OLABS Committee, which is composed of Larry Coady (Department of Fisheries and Oceans), Duncan Hardy (Canadian Oil and Gas Lands Administration), Camille Mageau (Department of Indian and Northern Affairs), Barbara Fowler (Newfoundland Petroleum Directorate), David Barnes (Newfoundland Department of Environment), Bob Wiseman (Department of Fisheries and Oceans), Clara Michelin (Labrador Resources Advisory Council) and myself.

This meeting represents the first comprehensive and interdisciplinary review of a document such as an IEA. The workshop sessions will encourage the participants not only to examine the sections for which they are individually responsible, but also to read and think about the document in its entirety. This process is an escape from the format of written correspondence for reviews that have typically gone on in the past, and which I have, in government and now in industry, found to be frustrating. I have always felt that there was so much more to be gained through open discussion.

This is a learning experience. It is hoped that what is learnt here will be applied to future reviews. For example, it is proposed that we do a review of the Eastern Arctic Marine Environmental Survey (EAMES) program data reports and that the reports be integrated sometime this fall. I think that we would like to encourage the same type of review by the academic community and government together with industry to evaluate that program.

In looking at the reason for this review, we must consider the histories of the IEA for offshore Labrador and of impact assessment in general. The IEA is <u>not</u> a document that allows an activity to take place. Exploratory drilling had been taking place on the Scotian Shelf, the Grand Banks and offshore Labrador prior to the start of the Offshore Labrador Biological Survey (OLABS) program in 1977 and prior to 1980 when this report was begun.

It is important to recognize that there is a degree of disparity in government's position. North of 60°N, the EAMES program was implemented to allow for exploratory drilling, while south of this "border" industry was free to conduct its drilling operations without such documentation. The OLABS program was designed as an extension of the EAMES program: to look at the potential implications of oil, particularly oil spills, that may range down from the Davis Strait to the Labrador Sea; to understand the potential impacts of oil spills in the Labrador Sea; and to plan oil spill contingency measures with greater ability.

Energy, Mines and Resources (EMR), Petro-Canada and the oil companies recognized this need for consolidation and documentation of the data base. The IEA provides a description of the environment, an assessment of impacts, and a discussion of the issues involved with offshore activity. The term IEA was chosen because it was felt, at least by Petro-Canada, that it does not infer a request for approval of a project, unlike IEE (Initial Environmental Evaluation) which is part of the Environmental Assessment and Review Process (EARP).

One of the objectives for which we are here today is to determine if this document is suitable to support oil

spill contingency planning on the Labrador Coast. It could then be used by Petro-Canada and possibly also by Chevron, Dome, BP and other companies. The IEE prepared by Mobil Oil for exploratory drilling on the Scotian Shelf was used by Petro-Canada. EMR had requested preparation of that IEE in support of contingency planning.

Normally the Canadian Oil and Gas Lands Administration (COGLA) organizes a scientific review of an IEA or similar documents, involving both government and industry. On the basis of that review they could approve of the document in support of contingency planning. What we have tried to do here is to extend the review to involve the provincial government, universities and residents. We hope that you will assess how well Petro-Canada has done in putting together the IEA, and what further information should be included in support of exploratory drilling. The purpose in holding an open forum is to provide a means of information exchange. We believe the people of Labrador are interested in and have the right to know about what is being done. They have the right to express their interests and concerns and should have the opportunity for doing so in a forum rather than through correspondence.

I would like to explain that the IEA is not a review of the OLABS program. When this document was in its final stages we were only about one-quarter through the OLABS program. We recognize that this document, like most of its kind, was outdated when it reached press; many of the 1980/1981 OLABS reports were not ready. One of the purposes of involving the resource people in the workshops is to present an update of the OLABS studies completed since the IEA was written. Another program parallel to OLABS is the Labrador Offshore Resources Study (LABORS) program, which is a series of physical environment studies undertaken in support of preliminary engineering design necessary for offshore production systems. This work was done and supported by Petro-Canada and its partners and was not a federal requirement. Much of the oceanographic, meteorological ice and geotechnical information was incorporated in the IEA. Joe Buckley, Bill Thompson and John Miller from Petro-Canada are here as resource persons who have been involved in the collecting and analysis of data and they have contributed to the writing of the IEA. We feel that you will benefit from these people and will gain a comprehension of the information that is available.

We have asked Bevin LeDrew to complete a summary of these discussions, and towards our objectives, to include an assessment of how adequately Petro-Canada and its partners prepared the IEA and to document your feelings on the adequacy of data.

I will ask you to bear with your chairpersons as they bring the discussion back to the basic questions - organization of the IEA, is the information readable, and how

complete is it. This review will be a learning experience. We hope that, whatever your area of expertise, you will participate in discussions of those elements of the document not in your field and will ask pertinent questions as you can. You will be meeting other scientists and managers, and this is an opportunity to appreciate the ideas of your colleagues and of the exploration people involved in activities along the Labrador Coast.

We all recognize that this is an active stage in the evolutionary process of impact assessment in Canada. We are all aware of the Environmental Studies Revolving Fund that is available, the efforts, new legislation and responsibilities of COGLA. We are also aware that many of you in this group may well be making applications to COGLA for environmental studies. I hope that in the discussions and debates that you do listen to the points that your colleagues are making. This will assist in appreciating what is required, where we are in the process of evolution of impact assessment and the efforts of COGLA, and will help in the organization of programs that might be funded by the Revolving Fund.

I encourage you to work hard, to get to know each other and to participate as much as possible.

OFFSHORE LABRADOR DRILLING OPERATIONS - BRUCE BERRY

(Mr. Berry's address to the participants reviewed drilling operations in general with emphasis on activities which are site specific to offshore Labrador. As well, he outlined the drilling program planned for 1982. The talk, illustrated with overheads and slides, provided a good background for the substance of the workshop sessions).

Petro-Canada is now the operator for the Labrador Group of Companies, having taken over this role from the Total Eastcan company which functioned as the operator from 1973 to 1979. Much progress has been made in exploratory drilling off the Labrador coast since the first attempts in 1971.

The sequence of events in exploratory drilling begins with examination of geological structure for potential hydrocarbon-bearing zones. Mr. Berry described subsea geological structures, seismic surveys and bathymetric mapping. The drilling operation was covered in detail: casing string placement, Blow Out Preventor (BOP) functioning, disconnect operations, drilling mud components and their functions, hydrocarbon testing, and finally, well abandonment. Offshore logistics include onshore marshalling areas, helicopters and supply ships. Third party services (mud logging, cementing, position detection, ice surveillance and weather forecasting) provide expertise to specific drilling and related activities.

2.2.2 Session A - Resource Presentations and Discussion

The resource persons for this session were Jean-Marie Sempels (Geology, Coastlines and Geotechnical Hazards), John Miller (Ice) and William Thompson (Climatology/ Meteorology).

Each of these individuals gave a brief presentation to the workshop groups. In each case the presentations became interspersed with discussion of items of concern. A brief overview of the three presentations is presented below. The discussion which followed each presentation is documented by workshop groups.

Jean-Marie Sempels provided a summary of the report contents and provided an update on subsequent work in each area. Except for the section on coastlines, the sections under consideration do not contain original work, but represent a literature review. There has, since completion of the report, been no new work on geology/physiography. On coastlines, the information developed for the document "A Contingency Plan for Labrador" was not included in the IEA. There has also been considerable work undertaken since the preparation of the IEA. Coastlines near Nain, Makkovik, Hopedale and Cartwright were videotaped for mapping and classification. A computer program is being developed to retrieve coastline information for use in oil spill response.

Geotechnical hazards were described with some emphasis on the significance of unconsolidated boulder beds and their effect on drilling operations. Dr. Sempels offered an opinion that the section on geotechnical hazards could have been treated in greater depth to better describe the hazards posed by these issues (shallow gas, boulder beds) and to provide an opportunity to discuss the strategies used to address these hazards.

John Miller presented an overview of material in the IEA and an update on ice related projects under way or planned.

The ice in the Labrador Sea is predominately first year, with multi-year ice occurring as an import from Davis Strait and Baffin Bay. First year ice is characterized according to stage of development and thickness (new, grey, grey-white). The maximum proportion of this ice is reached in February. Thicker, older ice is relatively more prominent later in the season.

The patterns of ice extent progress from north to south and from the shoreline seaward beginning in northern regions in November. The maximum extent of ice cover is reached in April when ice may extend to the Grand Banks.

By late May or early June the pack ice edge has usually retreated north as far as Groswater Bay.

Concentration of ice varies with distance from shore. Shearing takes place along the edge of landfast ice. At the seaward edge, the effect of wave action creates a localized peak of concentration.

Surface roughness also varies with distance from shore, with maximums occurring at wave-ice contact. Floe size varies across the width of the pack. Very small floes (less than 20 m diameter) are found near the ice edge, and size increases to the interior of the pack with large to vast sizes of 100-5000 m. Wave energy and its attenuation by the ice accounts for the range in floe sizes. High frequency waves attenuate rapidly whereas only longer period swells penetrate to the interior of the pack.

Ice motion can be described on a regional or local scale. Generally the ice moves to the southeast at about 10 km/day. Local movements in the order of 15-30 cm/sec also occur. The estimated maximum speed of ice movement is 190 cm/sec, and this is based on an assumed coupling coefficient applied to a maximum storm event.

The maximum thickness of undeformed first-year ice has been calculated at 1.5 m. Undeformed ice is, however, a minor component of the Labrador pack. Rafting and ridging creates ice with thickness of 1.5 - 5 m. Maximums to 7 m have been reported.

Ridges form when ice buckles under pressure. Laser profilometry suggests there are about four ridges per kilometer, however, this may be an overestimate.

Salinity is an important character as it affects ice strength. Mean salinities in young ice are 10-15 parts per thousand. Older ice is in the range 4-8 $^{o}/oo$. Vertical gradients of salinity exist but can be masked with flooding and rafting.

Density of first-year ice is in the range of 850-920 kg/m^3. Crystal structure comprises medium to fine grained (5 mm) components with a random c-axis orientation.

Ice strength information is not extensive, and has often been derived from small scale tests which are inappropriate for large-scale applications.

Icebergs originate in Greenland and, to a much lesser extent, the Arctic Archipelago. After calving, it

takes an average of 2-3 years for an iceberg to reach southern Labrador. The residence time off Labrador is very short as the icebergs drift southward.

Most of the knowledge of iceberg size is based on observations from drill rigs, hence the data represents bergs on the shelf and not those occurring along the marginal trough or the continental edge and rise. Typical dimensions are: length 550 m maximum, 100 m median, draft 225 m maximum, 77 m median. Mass is inferred on the basis of physical dimensions. John Miller quoted a maximum of 25-30 million tons, whereas others in the workshop groups felt this should be 40-50 million tons. The maximum mass that can be effectively "towed" is 2 million tons.

The numbers of icebergs that occur is not well documented and a good data set needs to be developed.

Studies now underway or planned were summarized. Those studies in progress include:

a. Regional Iceberg Mapping

   This involves re-working a data set used by C-CORE to calculate iceberg density distribution by season.

b. Three types of remote sensing devices are being examined for use in mapping ice type and extent (passive microwave, active microwave, and visible and near visible infra-red).

c. Ice characteristics of the marginal ice zone are being examined to see whether models developed for other areas can be applied to the Labrador pack.

d. Sensors are being evaluated for detection of deformed ice.

e. The effect of averaging interval on iceberg velocity is being examined.

Proposed studies include:

a. Regional Sea Ice Mapping

   The present Atmospheric Environment Service (AES) (Ice Central) services to support shipping are limited to 56°N. Petro-Canada has proposed a joint program of helicopter and icebreaker surveys to examine physical, mechanical and motion characteristics of pack ice.

b. Iceberg Flux.

An examination of requirements to obtain better numbers.

c. Consideration is being given to further use of laser profilometry or air-photo interpretation to study rafting and ice deformation.

d. Iceberg stability studies.

e. Iceberg motion will be studied by deployment of tracker buoys.

Bill Thompson described the data base upon which the Climatology section was based.

He pointed out that Petro-Canada has recognized the shortage of data, particularly from the North Coast. Three satellite recording stations have been installed on offshore islands as close to the shelf as possible. Other meteorological data is gathered wherever opportunity permits.

Several corrections to the IEA material were noted.

GROUP 1 DISCUSSION - Dr. David Stone, Chairman
- Mr Anthony Shallow, Rapporteur

Geology and Physiography, Coastlines and Geotechnical Hazards

1. There was considerable discussion of coastline work and an expression of concern that Petro-Canada continue fine scale mapping, and further that more recent work be somehow integrated into the IEA document.

1. (Response) The IEA will not be revised and reprinted.

2. The issue of modifying the document (why and how) received some consideration at various times through this session. Since much of the recent work is considered more valuable than that which preceded (and was included in) the IEA, there was a strong feeling that some means should be found to incorporate this material.

2. See response 1.

3. There was an expression of interest in the development of a computer program for storage and retrieval of coastline (geological) data. Support was expressed for the concept of expanding this model to include biological and socio-economic information.

   The practicality of videotaping the entire coastline, or just the low energy areas, was considered and concluded to be unfeasible. Some discussion then centered on the rationale for trying to clean a beach, as even areas like Porcupine Strand (a long stretch of sandy beach) are hardly tourist attractions at present.

3. Comment accepted.

4. The consideration of the relevance of each section to the entire document led to a discussion as to whether the geology section contained unnecessary detail (e.g. on terrestrial geology of Labrador). The consensus was that the section on geology would have done well to concentrate on the region from shorelines seaward with specific emphasis on coastlines and the geology of petroleum-bearing structures.

4. Comment accepted. Terrestrial information is not especially relevant.

5. The discussion on geotechnical hazards first focussed on boulder beds, their significance to drilling operations and their relevance to environmental impacts. The potential problem identified was one of delays that could be incurred in drilling a relief well in the event of an uncontrolled blowout. Unfamiliarity with technical details hampered discussion. However, given the short drilling season that exists, and keeping in mind the actions that would be necessary in the event of such a disaster, it was considered unlikely that boulder beds would, for example, cause a great delay in relief well drilling. In any event, new techniques to identify boulder beds, and the area of site surveys (2 km x 2 km) should ensure that this is a known factor in the event of an emergency.

5. Agreed. Boulder beds may cause downtime in routine operations, and could cause some delay in relief well drilling.

6. It was suggested that, for completeness, a discussion of shallow gas problems, liquifaction and turbidity should have been included in the geotechnical hazards section.

6. Shallow gas and liquefaction were, in fact, discussed in the IEA, although the discussion was brief. Neither have been a problem in drilling to date. Petro-Canada presumes that "turbidity" in fact refers to "turbidity flows", which might be a problem if drilling were to take place in submarine canyons or in saddles, instead of on the banks.

Sea Ice and Icebergs

7. While John Miller's presentation was well received and generated considerable questioning aimed at educating the participants, there were several criticisms of the IEA document, and of the supporting reports referenced therein. This raised the issue of accessing and assessing referenced documents. Many industrial research reports do not go into the public domain and are kept proprietary, at least for a certain period. A participant from COGLA pointed out that ultimately his agency hopes to make all data (but not necessarily the analysis) available publicly.

7. This is a potential problem with LABORS information; as there seems to be a clearly formulated policy on release of these data. Interested scientists should request information from the Manager of the Labrador Group.

8. Workshop participants presented several areas of research needs. An enhanced understanding of freeze up processes along the Labrador Coast was one such item. There is inadequate documentation in this area and historical data is lacking.

8. Mr. Miller finds the term "freeze-up processes" vague. He is still not certain what was implied here.

9. With respect to icebergs, the data base north of 52°N is virtually non-existent. Recent improvements in data collection have been achieved through cooperation between AES and Petro-Canada. The results of these efforts need to be consolidated.

9. Archival and analysis of sea ice and iceberg data is an ongoing project in Petro-Canada.

Climatology

10. In responding to Mr. Thompson's presentation, W. Appleby raised a concern about the document's description of atmospheric pressure in relation to the Icelandic low and the Bermuda high. Notwithstanding the influence of these two pressure zones, he felt it might have been better to have discussed this issue in terms of tracks, i.e. the north-south migration of tracks through the seasons, and the intensity of transient low pressure areas. Recent work on East Coast storm tracks had been completed by AES staff.

Mr. Appleby suggested as well that text references to storms of tropical origin may leave the uninformed reader with an impression that they are significant. Mr. Thompson concurred that storms of tropical origin, while of significance to the Scotian Shelf and Grand Banks, are not significant on the Labrador Shelf.

10. Comment accepted.

11. Discussion moved to the inconsistencies apparent between land and sea-based wind data. These may be attributable to differences in elevation of sensors and, as a result, the data base is unreliable. There are no standards for averaging period, and there is considerable variation between standard procedures and an independent ship sensor that operates on a selected averaging period. From an engineering point of view, Mr. Thompson stated that the data and procedures are not adequate and adjustments will have to be made to standard meteorological (regulatory) procedures to develop a system for dealing with the offshore.

11. **Coastal weather stations are affected by a rougher underlying surface (which affects winds) and temperatures are more variable than at offshore stations. Offshore weather data have a sampling bias in favour of the south coast.**

12. Mr. Appleby cautioned that in texts such as the IEA, due recognition should be given to the problem of fair weather bias in the data, particularly in northern areas.

12. **Agreed. The "fair-weather bias" was acknowledged several times in the IEA.**

13. A question was raised as to the adequacy of information on icing. Again Mr. Thompson referred to the problem with the crudeness and inconsistencies of observation/measurement procedures. The work done to date by NRC has used information on fishing vessel (trawler) icing. These are based on relatively crude visual observation, and while they may be relevant to supply boats, rig icing may be a different problem, requiring use of a different model to predict its occurrence. A proper sensor needs to be developed, adequate data obtained and computer models tested, especially as icing will be a problem to operators on the Labrador shelf.

13. **To date superstructural icing has not been a problem. It could become a problem if the drilling season off Labrador were extended to late autumn and early winter.**

GROUP II DISCUSSION - Mr. Lawrence Coady, Chairperson
- Ms. Gerry Collins, Rapporteur

Geology and Physiography, Coastlines and Geotechnical Hazards

14. The group expressed the opinion that, while coastal geomorphology information is relevant to the document and important in terms of contingency planning, the descriptions of onshore geology and offshore bedrock geology are irrelevant.

14. **Agreed. See response 4.**

15. The composition of seabed surficial sediments is considered important in identifying ice-rafted material as to source and type.

15. **Comments noted.**

16. The group discussed the integration of resource use activities into any shoreline mapping exercise. A resource harvest study of coastal Labrador now underway will include information on areas where people hunt, fish and have gear. Preliminary mapping of this information is underway. When completed, it could be integrated with shoreline sensitivity mapping.

The group discussed the meaning of the term "sensitivity" as used to describe coastlines, and the difficulties of assigning priorities to, for example, an unused biologically sensitive area versus a resilient but heavily utilized zone. The implementation of the proposed computer system should eliminate or reduce the problem of ranking priorities.

16. Agreed.

17. The group considered the difficulties of developing an effective contingency plan for coastlines based on the computerized system. At present the data base is inadequate to serve this purpose. At present there are problems of scale when data is portrayed on maps (e.g. 5 km of shoreline portrayed as 20-80% beach). Again, this problem should be resolved once adequate information is obtained and placed in a computerized data bank.

Dr. Sempels pointed out that the role of ice in coastal geomorphology is poorly understood and is the weakest link in understanding the physical parameters involved with shorelines. Work on the Baffin Island Oil Spill (BIOS) program will hopefully clarify the role of ice to some extent.

17. Disagree. The data base is adequate for computerized mapping.

18. Dr. J. Payne commented that it is extremely important to understand sensitivities to oil in the intertidal and inshore zones. Mr. L. Coady pointed out that the technology doesn't exist to respond effectively to a spill in the inshore zone. Dr. Sempels agreed and pointed out that a practical approach to achieve that which is possible is necessary, otherwise contingency planning becomes solely a paper exercise. Even given the lack of technology to deal with a shoreline cleanup, Mr. Sempel's work on a computerized data base was considered by the group to be useful because, in any case, there must be accountability in the event of a spill (i.e., the wherewithall to document impacts). Work on impact prediction must continue, the group agreed, even given that the technology does not exist to respond to a spill. Dr. Sempels summarized by saying the Coastlines

section was an academic-oriented verbal description of shorelines. It was not written for the purpose of contingency planning.

18. **Comments noted. This is perhaps a pessimistic view of contingency planning technology.**

19. Sections 5.1.4.3 (Topographic Features of the Seafloor) and 5.1.4.4 (Seafloor Sediments) were weak according to Dr. Chari. Dr. Sempels agreed, saying the sections were written from published literature rather than site specific surveys.

19. **Petro-Canada agrees this section lacked the depth of scholarship of the other geological sections. Section 5.3.2 is, in fact, a precis of the site surveys done for Total Eastcan and Petro-Canada by a geotechnical consultant.**

20. Dr. Chari also commented that Ocean Engineering (Memorial University) and the Centre for Cold Ocean Resources Engineering (C-CORE) are both doing relevant studies on seabeds and yet Petro-Canada did not use these information sources. It was agreed that future liaison is necessary between Petro-Canada and Newfoundland Institute for Cold Ocean Sciences (NICOS), C-CORE, and Ocean Engineering, concerning research on geotechnical aspects of seabeds, sediment distribution, geological seabed aspects, bottom currents and bed material transport.

    The section on earthquakes (5.3.11) was weak according to Dr. Sempels. It was based on information published in the 1960s. More recent information is available and should be tapped.

20. **Agreed.**

21. The information presented on iceberg scouring is brief and of little value, according to Dr. Chari. There is no point in merely giving the length of an iceberg scour without describing the sediment type, bottom topography and the maximum size and frequency of the icebergs in the area.

21. **Comment accepted.**

    Sea Ice and Icebergs

22. The lack of iceberg data from troughs was explained as a reflection of sampling. Oil companies obtain iceberg information (generally) only where drilling is taking place, and no other agencies are working in the area to obtain this information.

22. Agreed.

23. Responding to a query about Petro-Canada work on risk assessment, Mr. Miller observed that he had no faith in what he felt was purely a mathematical exercise with answers dependent on how the problem is defined.

Mr. Miller was asked what he saw as the major data gap related to ice. Time distribution information on iceberg scouring was described as the major gap. At present it is not possible to differentiate on a scale of 10-20 years how many iceberg scours have been made over that period in a given location.

23. Mr. Miller stated that the results of risk analysis are, to some level, dependent on the risk model formulation and the data that are used. Without a well defined model and good data, results must be considered tentative and not definitive.

24. Mr. Miller and Mr. Thompson pointed out a problem encountered by their company. Because of budget restrictions, neither AES or MEDS is capable of filling its defined mandate of providing basic information.

Climatology

When asked how weather forecasting for the offshore (Labrador) can be improved, Mr. Thompson responded that a better network of weather stations is necessary. In the fall, when winds pick up, the pressure gradient lies offshore. A possible means of obtaining the data could be to use air deployable drifting buoys when required.

24. Agreed.

GROUP III DISCUSSION - Dr. Norman Williams, Chairman,
- Ms. Katrina Hodgson, Rapporteur

Geology and Physiography, Coastlines and Geotechnical Hazards

25. It was felt that the information contained in the geological section is both well presented and reasonably complete. There was some discussion on the appropriateness of inclusion of this section in the document and its relevance to the assessment process. Some participants felt the section was important to the integrity of the IEA and hence should be included. The recommendation was made that geological information be presented as a background or supporting document to the IEA.

In discussing the section on Coastlines (5.2) Jean-Marie Sempels pointed out that, as part of its socio-economic program, Petro-Canada has begun work on an Atlas to delineate resource use activities in coastal areas. The working maps and computer data bank that will result are designed for use in contingency planning.

25. **"Geological information" is used vaguely here. Petro-Canada agrees that information on onshore geology, quaternary geology and onshore physiography was not essential. However, the petroleum geology of the Labrador Shelf was necessary.**

26. Dr. Peter Smith criticized the latitudinal format used in describing coastline types, in that the inclusion of areas not immediately accessible to the coast (i.e. Lake Melville) gives an inaccurate perception. Jean-Marie Sempels acknowledged this distortion but pointed out that this method of data compilation was used to avoid lumping the whole coastline together.

The omission of the Strait of Belle Isle region was criticized as a major deficiency. Wayne Speller acknowledged that the Strait area is recognized as a target for spills originating in the Labrador Sea, although it is outside the operational area.

Dr. N. Williams stated that the creation of the Atlas will help enormously in the interpretation of IEA data. The overlaying of resource uses with biological, socio-economic, geological and coastline data will allow further specification of impacts in coastal zones and the priority rating of areas. Clara Michelin noted that the Labrador Resources Advisory Council (LRAC) is pleased with Petro-Canada's effort with the Atlas.

26. **Had the whole coastline been lumped together, there would have been much more distortion of the results.**

27. In summary, the group felt the coastline section was comprehensive and well illustrated. It is very relevant to the IEA. The maps presently included in the Contingency Plan for Labrador should be part of the IEA and would aid in impact predictions.

It was felt that some ambiguity had been created by inclusion of the Geotechnical Hazards section (5.3) in a document which addresses exploration, but implies production. D. Karasiuk pointed out that this section would be extensively rewritten in the event of impending production. The section was criticized for containing generalized, inadequate and outdated information.

27. **See response 19. Comment accepted.**

28. Improved site surveys should upgrade the quality of information available. At present soil properties are being researched. There has, however, been no consistent attempt to map ice-scour in the Labrador Sea although it represents a risk to offshore operations. Similarily the impact of landslides on wells is not known. Storm surges and salt dome pressure changes are not mentioned.

    Jean-Marie Sempels provided response to some of these comments. He also pointed out that the seismic information is based on sparce data. Petro-Canada has proposed the establishment of recording stations at Nain and Goose Bay to provide reliable data equivalent to other areas.

    The group concluded that the accumulation of data base for any future production should be started now.

28. **Ice scour frequencies are recorded as a part of site surveys. It would indeed have been useful to have regional information on slope stability. "Storm surges" and "salt-dome pressure changes" are irrelevant to offshore Labrador operations: storm-surges are a problem on gently shelving coastlines but would not be noticeable offshore; no evaporites (and therefore no salt-domes) are known to occur beneath the Labrador Shelf.**

    <u>Sea Ice and Icebergs</u>

29. Dr. Peter Smith advised caution in applying Beaufort Sea ice experience to Labrador pack situation.

29. **Agreed.**

30. Mr. John Bursey, in discussing AES services and proposed joint programs with Petro-Canada, expressed concern that communications between these two agencies are not good at this time. This may be in part due to an absence of relevant policy by AES and this is now being addressed by a policy paper that is in draft form.

    The separation of AES from oceanographic services (Marine Environmental Data Service - MEDS) also creates problems. The poor communication within government agencies appears to be hindering the development of a good ice forecasting ability.

    Mr. John Miller responded to questions on iceberg stability modelling by pointing out that these models are all theoretical and have not been tested in real life. Iceberg movement is not predictable as the present knowledge of current and wind effects is inadequate.

30. **Close personal communications at the working level might also be helpful.**

31. Peter Smith argued that the present ice knowledge is inadequate for future engineering designs and for exploratory work in ice cover. John Miller pointed out that Petro-Canada will not consider exploratory drilling during the pack ice season given the present state of knowledge about ice. The group concluded that the section on ice was comprehensive but largely inadequate for conceptual designs.

31. **Last sentence should read: "Iceberg movement is not predictable because the present knowledge of forecasting current and wind effects is inadequate.**

Climatology

32. Mr. C. Noll expressed a concern that data on icing be analyzed. Since these measurements are part of a routine drilling program, they should be readily available. Data from the Zapata Ugland are now housed with AES but apparently have not been analyzed.

John Bursey and William Thompson discussed the need for improved communications between regulatory (COGLA) and Service (AES) agencies. COGLA sets industry requirements for data to be gathered. AES needs the data to make predictions, but to date has had difficulties in obtaining funding to fulfil these obligations. Turn-around time is slow and industry can't benefit from these observations because they are not readily accessible.

The group concluded that the meteorological section was comprehensive and relevant.

32. **Comment accepted.**

Summary

The summary conclusions of Workshop Group III on Section A were:

33. 1. Updates and corrections of the IEA should be made fully available.

33. **A revised IEA will not be produced. Additional information will be made available through the OLABS program, and to federal and provincial regulatory agencies.**

34. 2. Coastline maps should be included in the IEA to help in impact predictions.

34. Comment noted.

35. 3. Priorities for coastline studies and contingency planning should be set through overlaying resource uses with biological, socio-economic, geological and coastline data.

4. Government should assist in supporting remote northern automatic weather recording stations.

5. Government should make environmental data available quickly to industry.

6. COGLA and Service agencies (MEDS, AES) should better plan the implementation of studies required of industry which are supported by or mandated to these service agencies.

7. Data for the Zapata Ugland on superstructural icing should be analyzed.

8. Observation procedures for sea state should be upgraded and standardized.

35. Recommendations noted.

2.2.3 Session B - Resource Presentations and Discussion

The resource persons for this session were Dr. Joseph Buckley, a physical oceanographer with Petro-Canada, and Mr. Robert Buchanan, a biologist with LGL Ltd. There was no resource person assigned specifically to fish and fisheries, however, in each workshop group there were participants with a background in fisheries research or management.

A brief review of the two presentations made is presented here. The specific discussion which flowed from these presentations is then presented for each workshop session.

Dr. Buckley's presentation included a review of the information presented in the IEA, plus a discussion of research initiated or planned since completion of that document. In general, he pointed out that the data base has doubled since the IEA was completed. This new information will be released as an OLABS report and, hence, will become publicly distributed.

The Physical Oceanography section of the IEA was divided into three basic sections - water mass analysis, current structure of the Labrador Shelf, and wave climate. Water mass analysis is common knowledge in the literature, and little new information was presented in the IEA.

The section on water currents pointed out one fact that is rarely dealt with explicitly, i.e., mean circulation on the banks is quite low. In the slope area the current is steady, as it is in the shallower areas of troughs. On the banks and in deep water of the troughs, currents are unsteady and show no preferred direction. These observations should have a profound effect on the biology of the region.

The wave climate information is based on three sparce data sources - wave rider measurements, METOC charts, and wave hindcasts. While wave rider data is of high quality, the duration and distribution of data is limited. METOC charts are based on visual observations and tend to lack precision. Hindcasts are critically dependent upon the quality of meteorology and, in the area of interest, such exercises have tended to underestimate strength of wave fields. There hasn't been a concentrated effort to collect wave climate information. Unless and until the drilling season is extended, this is not seen as a major data gap.

Dr. Buckley went on to outline results of work completed in 1980 and 1981 (and not included in the IEA). One interesting feature was revealed by the Dynamic Height Plot (roughly equivalent to surface currents). In the region of

Southern Hamilton Bank, it is apparent from the Dynamic Height Plot that the water is going around in circles, bringing warm (salty) water in from the slope onto the banks. This transport mechanism moves the kind of water in which cod prefer to spawn and, hence, may be significant biologically. Dr. Buckley noted that similar features have been observed in other areas, e.g. Nain Bank in early August.

Temperature/salinity measurements taken from the deep water in the trough south of the Hopedale saddle reveal an interesting phenomenon. This trough water is well separated from slope water, yet the majority of stations sampled were found to contain water similar to slope water. This means that water of the same density exists at 150 m water depth in one location, and at 270 m in another, both cases occurring in a well stratified environment. An examination of isohalines reveals that they slope very steeply and are roughly parallel to the bottom, so there is a direct connection between this trough and slope water.

Tidal signals were another interesting phenomenon. Although not extremely strong, shallow and deep water tidal currents are significantly different. This is somewhat curious since it is commonly assumed that tidal currents are more or less the same from top to bottom of the water column.

In 1981 two satellite tracked surface drifters were deployed at drill sites, one on Saglek Bank and one on Nain Bank. The Saglek Bank buoy moved south along an inshore branch of the Labrador current. It moved offshore in the area of Hopedale Saddle, performed a five-day loop on Harrison Bank, came inshore in the area of Cartwright Saddle and was headed for Ireland when the January 18, 1982, storm returned it to the Avalon Channel. The second drifter didn't go through any loops, followed the marginal trough and passed into the Strait of Belle Isle. It was retrieved in April from pack ice near Corner Brook.

Mr. Buchanan pointed out that he was not responsible for the Chemical Oceanography section of the IEA. Parts of that section were based on OLABS reports so he proposed to review the relevant OLABS studies to give the group an awareness of the information gathered to date.

The effort began in 1979 with a shipboard study in which there were 44 oceanographic stations in 9 transects along the shelf and 16 bay (inshore) stations. Temperature/salinity, chlorophyll, phytoplankton, zooplankton, ichthyoplankton and nutrient measurements in the upper 50 metres were taken. The major contribution of the study was to upgrade the biological oceanographic information in the inshore area, about which little is known. Nutrient background levels in shallow water are now documented. One interesting

finding was the high silicate concentration in the nearshore. Whether this is an influence of the shoreline or of Arctic waters is not known. No information on oxygen levels was collected in 1979.

Also in 1979 a Near Shore Benthic Study was carried out from Makkovik to Cartwright. The study gathered information on species composition of macrophytes, concentrations of invertebrates, abundance, biomass and community structure. This study attempts to relate organisms to habitat (substrate) type. This could lead to a biophysical classification of the shore zone.

There have been several OLABS fisheries studies and these were summarized by Mr. Buchanan. A cod and turbot feeding study carried out in 1979 documents species composition and relative importance of food items in inshore waters (August-September).

A fisheries review also conducted in 1979 brought together information on fisheries with emphasis on the East Coast of Labrador.

In 1980, invertebrate zooplankton samples (collected in 1979) were analyzed in terms of distribution, species composition and biomass.

Also in 1980 a study was continued of Atlantic Cod and Rock Cod feeding. In 1981 an Inshore Cod Study was conducted according to terms of reference developed by Federal Fisheries. This represented a continuation of the cod feeding studies of previous years, but in addition was aimed at establishing reasons for the disparity in cod numbers from two areas. It was hoped this study would provide some insight into the factors which influence inshore cod abundance.

GROUP I DISCUSSION - Dr. David Stone, Chairman
- Mr. Anthony Shallow, Rapporteur

Physical and Chemical Oceanography

R. Wiseman noted that the IEA refers to slope water, saddle water and shelf water. He asked whether one can now describe trough water as a result of CTD (Conductivity-Temperature-Depth) analysis. J. Buckley replied that there is no distinct water mass type in the trough. It is either slope water (at depth) or essentially the same as water on the banks. That there wasn't a specific trough water, was one of the interesting points of the CTD program. It had been known that deep water in the trough is different from shallower water, but to find that this deep water has the same characteristics as offshore water was a significant find.

W. Appleby, in referring to the IEA discussion on wave conditions, suggested that more emphasis should have been given to the fact that it is an extreme analysis. Even though this is stated at the beginning, the impression left after reading the section is that it just relates significant wave heights at particular points, when in fact an extreme significant wave analysis technique has been used.

Dr. John Lazier enquired about plans to put some of the OLABS (1981) analysis into the (white) literature. Dr. Buckley pointed out that the main problem is one of finding time to write up the material.

Dr. Lazier asked whether results of 1981 work would be incorporated into the IEA document. J. Buckley said no, that the IEA represents the status of knowledge as of the date of its completion. OLABS reports will document subsequent work.

36. In responding to a question on further research needs, Dr. Buckley expressed an opinion that the study season should be pushed further into the fall and early winter season. R. Wiseman felt the lack of seasonal information constituted a significant data gap for both physical and chemical oceanography. As well, the practicality of extending transects over the shelf banks should be considered. It is recognized that current interaction and distance creates logistical problems that may necessitate the use of larger ships.

36. More precisely, wave-current interaction may increase wave steepness.

37. R. Wiseman asked whether there had been a program to assess the levels of hydrocarbons in the water column on the shelf. When he was told no, Mr. Wiseman pointed out that in the future it may be considered important to know background levels. This led to a discussion of how research priorities are established, and the relative importance of this proposed activity.

37. Agreed. Assessment of background hydrocarbon levels was a program suggested in the IEA.

38. In concluding comments on this section it was pointed out by R. Wiseman that the work done to date, while quite useful, enables one to make only qualitative impact predictions. This points out the immensity of the task required to be able to make quantitative statements about impact.

38. Agreed. Is quantification even a feasible objective in an area the size of the Labrador Shelf?

<u>Microbiota</u>

The discussion started with a comment that it was surprising to see this topic covered in the IEA with little more than one page of text. It was suggested that this probably reflected the state of knowledge in this area. Nonetheless the group consensus was that the microbiota section was deficient.

<u>Primary Producers</u>

39. R. Wiseman raised the issue of ice algae and the sparce data on the epontic community. Mr. Buchanan agreed this was an important data gap, however, the BIOS program may serve to fill some of these gaps. It could be a useful and logical exercise to try and identify the proportionate contribution to primary productivity of the epontic community. While it is unlikely to be anywhere near the level of phytoplankton, the contribution is probably not altogether insignificant.

Some criticism was directed at several unreferenced and unattributed comments made in this section.

39. This sort of information might be "nice to know". However, it has no particular application to contingency planning, the setting of environmental operating conditions, or engineering design.

<u>Zooplankton and Benthos</u>

No Comments.

Ichthyoplankton

40. R. Buchanan and R.J. Wiseman concurred that the lack of data for months other than summer was the major criticism of this section. The spawning period for cod (February-March) was missed in sampling and this is the greatest gap.

40. **This is, in fact, a deficiency of the literature and of OLABS, not of the IEA.**

41. R. Wiseman felt that it is important to have a good understanding of physical oceanography and then relate this information to egg/larvae locations.

On sampling again, R. Wiseman suggested that sampling program transects should be extended seaward over the shelf slope to improve the space and time coverage.

Dr. J. Buckley pointed out the practical problem of the time it takes to sample a selected grid area. If it is too large, the time becomes too great to complete one set of samples, hence repeat sampling is too infrequent. R. Wiseman pointed out that, hopefully, a good knowledge of physical oceanography would be used to provide a basis or design for a sampling program.

Some further discussion centered on the need and practicality of sampling during the season of ice cover.

41. **Agreed.**

Fish and Fishery

42. There were two general comments on these sections. Some readers were unfamiliar with the "common" names used for some fish species. The rationale for the order of presentation was unclear. It did not seem to follow an order according to species classification or economic importance.

R. Wiseman stated that the section on the commercial fishery was very well done.

42. **Comment accepted.**

GROUP II DISCUSSION - Mr. Lawrence Coady, Chairman
- Ms. Gerry Collins, Rapporteur

Physical Oceanography

43. The trough water, its low rate of circulation and its relationship to slope water caused some discussion and speculation. Dr. J. Payne wondered whether offshore

concentrations of shrimp might maintain themselves in the troughs. The similarity of trough and slope water could have implications for cod spawning as cod are known to spawn at the outer edges of the slope, in water at a temperature and salinity the same as occurs in the troughs.

43. **Agreed. A major topic of discussion during the seminar was the ways in which physical oceanographic processes influence biological processes.**

44. The eddies found at the outer edge of the Labrador current were discussed in some detail. The surface current travels in circles where these eddies occur, bringing warm salty water onto the banks. Ice conditions indicate the phenomenon continues into the winter season. If these eddies are present during cod spawning (April and May) there may be a relationship with, or effect on cod spawning activity.

Dr. Chari felt it could be useful for impact prediction to relate physical oceanography data to iceberg movement. As well, he felt that more information on waves is necessary.

A major gap is the lack of data for the winter period. Logistics make such an effort difficult and expensive and it was questioned whether funding for such work would be available in the absence of winter drilling (exploration) activity.

Mr. Duncan Hardie questioned whether physical oceanography of nearshore zones is well enough understood to predict impacts there. Dr. Buckley pointed out that the nearshore zone is more affected by the land-sea breeze phenomenon (which will determine where oil will come ashore), than by currents. This point could have been made more clearly in the IEA.

The inshore micro-environment is impossible to model at present, however, information on nearshore currents can be obtained by use of a system (CODAR) being worked on at C-CORE.

44. **Agreed. It would be difficult for industry to justify the costs of winter studies at present.**

45. The discussion on the Physical Oceanography section resulted in a consensus that it was well written, but dated.

45. **Incorrect. The "dated" information was only six months old at the time of the review seminar.**

Chemical Oceanography

Mr. L. Coady presented a DFO concern that chemical oceanography transects weren't run far enough offshore. Mr. Buchanan pointed out the practical constraints of vessel size and range. Dr. A. Hay supported Mr. Coady's comment in light of the apparent cross-shelf migration of slope water in the marginal trough.

46. The lack of use of MEDS chemical oceanography data was criticized and Dr. Buckley responded that the IEA did not involve analysis of data from outside sources, but presented a synthesis of the published literature.

46. Petro-Canada was not aware of the existence of these unanalyzed data. It hopes that MEDS will soon publish this information.

47. Dr. K. Columbus felt a large data gap related to the absence of information on heavy metal concentrations. This could become an environmental health consideration, hence baseline data on background levels could be important and could perhaps be collected during well-site surveys.

47. Agreed. This was also a recommendation of the IEA.

48. Asserting that chronic low level pollution around well-sites is more significant environmentally than the spectacular but rare blowout, Dr. Columbus felt that baseline/monitoring studies at chronic use areas should be implemented, using scallops or benthos as indicator organisms.

48. Comment noted. However, during exploratory drilling, no drillsites are "chronically used". After testing, a well is either suspended or abandoned.

Microbiota

49. Mr. H. Bain felt that it would be useful to initiate a program to study nutrient requirements of oleoclasts. In the event of a spill, needed nutrients could be applied in the spill zone to stimulate oleoclast growth, and thus a more rapid degradation of oil.

49. Preliminary information on nutrient requirements appears in Bunch (1979) for southern Davis Strait. The comment is interesting because it could, if researched and tested in the field, lead to a new spill response technique.

Primary Producers

50. Mr. Bain commented that, while the section on macrophytes provides a descriptive account, there is a need to tie this information into the food chain and to understand critical links. Mr. Duncan Hardie felt the lack of data analysis was a shortcoming. Dr. W. Speller pointed out that only three relevant studies had been carried out to date, hence there was a reluctance to draw conclusions.

Mr. Hardie asked whether the IEA reflected the essence of LGL's research. Mr. R. Buchanan felt his company could have provided a better summary of the research. This raised the issue of how to adequately summarize and present in one document the vast amounts of research which support an IEA.

50. The existing information on Labrador macrophytic algae is extremely limited - the IEA reflects this.

51. Dr. J. Payne noted the sparcity of information concerning the effects of oil on macrophytes. He felt government should carry out baseline studies of macrophytic algae in the Labrador Sea, while industry should carry out impact oriented research, for example on the effects of an oilspill on macrophytic communities. Mr. Coady pointed out that Mr. John Barrie's work was a valuable contribution to this subject and should have received more attention in the IEA.

51. This comment is incorrect. Pages 5-148 to 5-150 paraphrase the salient features of the OLABS work of Barrie _et al_. (1980).

52. On phytoplankton, Mr. Coady felt the IEA didn't devote much space to estimates of relative biomass, abundance and distribution. Some discrepancies between LGL results and the IEA statements were pointed out. For example, a statement was made that "chlorophyll distribution is regulated primarily by light". This point had not been put forward by LGL.

52. Invalid comments. See pages 5-150 to 5-155 of the IEA. The effect of light on chlorophyll _a_ distributions was a point that LGL made clearly on page 93 of Buchanan and Foy (1980); the IEA paraphrases this point accurately.

53. Mr. Buchanan was asked whether the work done to date is adequate to understand primary productivity or whether more work was necessary. In reply he stated that a long term systems approach is now needed to give the percent contribution to primary productivity by the ice biota,

macrophytes and phytoplankton. There is a need to understand seasonal succession and community composition throughout the year. These studies would take years to complete, yet in their absence the ability to predict impacts is weakened.

53. **Though "nice to know", this information has little practical application to design, countermeasures technology, or improved environmental operating conditions.**

54. Dr. A. Hay suggested LANDSAT (satellite) photos on the chlorophyll-sensitive band might be examined to detect gross changes in primary productivity over time.

Both Mr. Bain and Mr. Coady stressed the importance of process rather than impact-oriented research with respect to primary productivity.

Mr. L. Coady stated that the susceptibility of the epontic community to oil entrained in ice is seen as an information requirement. Dr. W. Speller responded that work being conducted by Dr. J. Bunch as part of the BIOS program will, hopefully, provide insights into this issue.

54. **At best, this technique might be an indicator of changes in standing crop biomass, not of productivity.**

<u>Ichthyoplankton</u>

55. The chairman (L. Coady) observed that the IEA gives numbers but not biomass or seasonality. Mr. Buchanan pointed out that this was a result of the date of the report. The LGL report on zooplankton adds much of the needed information.

55. **The IEA does, in fact, reflect the literature of that time. While LGL's OLABS work (published after the IEA) does report biomass, it did not provide new information on seasonal changes in the composition of the zooplankton community.**

56. The statement that <u>Calanus</u> <u>finmarchicus</u> is the dominant zooplankton species in the Labrador Sea may be subject to correction because it is probably not dominant on the shelf.

Mr. Buchanan noted some shortcomings of the LGL zooplankton study. The field work was started too late to cover cod spawning period. Sampling for vertical distribution of cod eggs and larvae could have been carried out to greater depths.

Mr. Buchanan noted that the zooplankton found was Arctic in composition.

56. Incorrect comment. LGL's OLABS work has shown that *C. finmarchius* is, in fact, more abundant over the shelf than in waters closer to shore, and that calanoids (including *C. finmarchius*) do dominate the zooplankton, in both abundance and biomass.

Fisheries

57. Mr. Duncan Hardie felt that, given the importance to coastal communities of salmon and char, the level of detail provided on these species was disappointing.

57. In this, Mr. Hardie contradicts his written comments of October-November 1981.

58. Mr. Coady stated that the document didn't fully reflect the changes that have taken place in the cod fishery. In the 1960s and 1970s as cod stocks declined, the inshore fishery became more diversified. With the resurgence of the northern cod stock, the cod fishery is again important in southern Labrador. As the stock continues to rebuild, it can be expected that the cod fishery will once again predominate throughout coastal Labrador.

58. These items were discussed on 5-210 and 5-220 to 5-221 of the IEA.

59. Mr. Coady also commented that, while the document reflects a good understanding of the fishery, it lacks information on oil industry-fishery interactions.

59. Comment accepted. NORDCO's recent analysis of the effects of petroleum exploration on the Newfoundland fishery was published in 1982, after the IEA.

60. Many aspects of cod life history remain speculative and this information will have to be gathered before effective contingency plans can be designed. For example, for the first time ever, seasonal groundfish surveys will be carried out during 1982 on the Northern Grand Banks. In the previous fifty years of biological research in the area, assessment surveys have always focussed on specific times of the year.

In summarizing the discussion L. Coady pointed out that much new information is being generated. While there is a need to focus on sensitive areas such as cod larval distribution and spawning zones, useful information will be gleaned from ongoing fishery management activities, e.g. "Foreign Observer" reports.

60. This is one of the purposes of the "cod larvae study" described in Section 8.6.6 of the IEA.

GROUP III DISCUSSION - Dr. Norman Williams, Chairman
- Ms. Katrina Hodgson, Rapporteur

Physical Oceanography

61. There were several observations made during and following Dr. Buckley's presentation. It was speculated that the wave oscillations observed are probably not regular but appear so because of intermittent observations. Whatever the frequency, these oscillations will depend on the strength of density changes, temperature and salinity differences between inshore and offshore, and the slope of density surfaces.

It was felt that the fate of water on the slope is a subject not thoroughly backed up yet by the data. There seems to be very little interaction between the outside edge of the bank, the bank, and trough waters, although some leakage does occur. It may be that, similar to Lancaster Sound, Labrador Sea water comes into the saddle, reverses and goes back out again, but this would probably not be a significant transfer mechanism.

61. Dr. Buckley is uncertain whether this comment refers to the variability of the inner edge of the Labrador Current. If so, the IEA did not make any explicit statements concerning regularity.

62. Dr. H. Lear observed that influxes through the saddle may be very important to cod movements. The mechanism for this movement might be related to temperature - salinity - density structures through the saddle, but because the velocity component of slope water is so small, it is difficult to track a "piece" of water.

The discussion moved to the possible response of birds and mammals to current eddies and oscillations. Dr. N. Williams pointed out that bi-weekly surveys during July and August (1979) on the Makkovik and Hopedale Banks and saddles showed very demonstrable shifts in seabird populations. It was agreed that it would be interesting to determine whether interactions exist between fluxes of physical oceanographic and biological components (e.g. greater shearwater, capelin).

The discussion moved on to water currents and icebergs. There has been an incorporation of surface current data into iceberg trajectory models. Velocity shear that occurs in the water column is not expected to have much bearing on iceberg movement. Dr. Buckley noted that Petro-Canada intends to collect surface current data in the area of iceberg tracks.

62. **Comment accepted. Currents and water masses could well be important factors governing the distributions of marine vertebrates.**

63. A series of recommendations were developed following the discussion:

- Current meter buoys (iceberg track) should be deployed at varying depths.
- Labrador water current data should be published.
- Temperature - salinity data from the Blue Dolphin Expeditions (1949-1955) should be analyzed.
- Computer links need to be established with AES to facilitate input/retrieval of data useful to modelling.
- Biological data should be merged with that of physical oceanography to see if there are interactions or relationships in space and time.
- Oil spill and ice trajectory models should be updated to include most recent current data.
- Parameters affecting iceberg drift need to be determined.

63. **Recommendations noted.**

Chemical Oceanography

Dr. R. Addison noted that DFO review comments include requests for further information on chemical oceanography. These technical review comments were tabled. Dr. Addison noted that most reviewers felt the data base for primary and secondary producers was well covered but there are some questions about interpretations of data.

Microbiota, Primary Producers and Zooplankton

64. One participant observed that the statement that phytoplankton in the Labrador Sea are fast growing is not supported by measurements.

It was observed that no direct studies or even surveys of Labrador ice epontic communities have yet been undertaken. In response, R. Buchanan offered the opinion that studies on nearshore primary productivity should be done form the perspective of the relative amounts contributed by epontic flora, macrophytic algae and phytoplankton. He suggested that the BIOS studies of the effect of oil on epontic communities would be applicable to Labrador waters given the similar species compositions.

Benthos

In discussing this section, Mr. D. Karasiuk acknowledged that the information was sparce and anecdotal, compri-

sing pieces written at different times. There are few relevant sources of information available. The only work done in the northern area of Labrador is proprietary until 1984. There is no information on deep water benthos.

Mr. Karasiuk stated that the biophysical approach to nearshore benthos studies used by John Barrie (in a recent OLABS study) represents a significant conceptual contribution for "mapping" marine ecosystems, and could be very useful for impact prediction if there was a broader data base. The present information was gathered from only two sites.

In discussing impacts, Mr. Karasiuk stated his feeling that an oil spill would have negligible impact on deep water benthos. In the instance of a blowout, the hydrocarbons in the water column at a depth of 200 m would be in the parts per billion range, if detectable at all. Mr. S. Akenhead disagreed with this scenario, pointing out that oil brought down in gyres might concentrate in certain areas and thus could affect benthic species reproduction. Dr. Addison, on the other hand, stated he wouldn't disagree with most of what Mr. Karasiuk had said. The prominent effects occur nearshore. As well, interfaces (sediment - water, air - water, land - water) are possibly the most sensitive zones for potential impacts.

64. **Invalid comment, resulting from a misinterpretation of a sentence describing the spring phytoplankton bloom.**

65. The discussion turned to the broad question of how to detect changes in marine ecosystems from oil. At present, this capability does not exist for Labrador waters. Such a capability requires much more than one or two years of studies such as those contemplated by oil companies. Mr. Karasiuk pointed to the BIOS program as an example of a study program designed to provide insights into the ecosystem.

65. **Agreed.**

66. The ability to detect change and separate natural from man induced variation is necessary for development of adequate monitoring and spill response plans. Monitoring is a poorly developed capability and may require a break from tradition to find new indicators of ecosystem health. Some possibilities discussed included oxidases and fatty acids.

66. **Agreed.**

67. D. Karasiuk pointed out that nobody has set criteria for assessment except fisheries biologists (who have economic goals in mind). Without such criteria it is difficult to say how studies lead closer to an assessment of what may happen.

67. See Beanlands and Duinker (1982) Environmental Impact Assessment in Canada: An Ecological Contribution for an evaluation of the seriousness of this problem.

68. Mr. G. McKinnon suggested that critical times and areas be defined to assist impact assessment, e.g. seabirds at moulting time are most susceptible to oil. Dr. N. Williams responded that the coastline mapping overlain with resource base information is an attempt in the right direction.

68. Agreed.

Fisheries

69. Little time was available to discuss fisheries. DFO and group comments indicated it was a good section. Some general comments were made:

- More data are needed, especially in the northern Labrador Sea.
- The far offshore is an unknown. The migration routes of salmon and other pelagic species are unknown.
- Fish and economic parameters need to be integrated to establish critical windows.

69. Recommendations noted. The meaning of the last recommendation is obscure.

2.2.4 Session C - Resource Presentations and Discussion

The resource persons for this session were Dr. Peter McLaren (Seabirds), Dr. Rolph Davis (Marine Mammals) and Ms. Natalie Sutterlin (Oil Fate and Effects).

70. Dr. McLaren pointed out the lack of information on seabirds and marine mammals at the time the IEA was completed. LGL conducted studies in the Southern Labrador Sea in 1981. These included aerial surveys and feeding studies.

The aerial surveys were flown from 56°N to Funk Island, Newfoundland, along predetermined flight lines every two weeks from mid-April, 1981, to mid-November, 1981. Thereafter flights were made at monthly intervals until mid-May, 1982. The survey lines crossed the marginal trough, shallow fishing banks, the shelf break, and, to a lesser degree, the deep offshore.

Another survey was done in the Strait of Belle Isle. The nearshore waters along either side of the Strait as well as some of the offshore areas were surveyed to investigate migrations of shearwaters, whales, seals and the yearly distribution of seabirds and marine mammals.

Feeding studies were conducted in Groswater Bay on those species, primarily alcids, nesting in the Gannet Islands. Shipboard surveys recorded bird counts, areas and physical parameters. Some bird specimens were collected to examine diet, and some net sampling was carried out to determine food availability.

Distribution maps for several species were presented to illustrate the results of aerial survey work.

Dr. Rolph Davis pointed out that the seabird aerial surveys enabled concurrent observations of sea mammals. He briefly described two other studies which have been conducted:

- A harp seal diet study, in which samples taken from hunter kills along the Labrador Coast were analyzed.
- A survey of northern Labrador marine mammals was an integral part of a larger survey (conducted in 1981) of all potential marine mammal habitats. The flight path followed was from Baffin Bay south along West Greenland and on the Canadian side along Davis Strait, Hudson Strait, Hudson Bay and down the Labrador Coast as far as Nain.

70. **The results of these studies will be published in late 1982.**

71. Ms. Natalie Sutterlin, in reviewing the IEA discussion of Oil Fate and Effects, pointed out that the data base has been largely developed from laboratory experiments. This raises the problem of extrapolating from small-scale controlled situations to areas which haven't been examined closely.

71. **Agreed. Recently, researchers have attempted experimental oil spills and microcosm experiments to avoid these problems of interpretation.**

72. As an example, it has been shown that hydrocarbon weathering in the natural environment is much lower than occurs in closed experiments. Another example is drilling mud toxicities. LD 50's of the components have been calculated in the lab but synergistic effects have not been examined.

72. **Not quite accurate. There have been a number of studies using whole muds.**

GROUP I DISCUSSION - Dr. David Stone, Chairman
- Mr. Anthony Shallow, Rapporteur

Seabirds

73. Following the presentation by P. McLaren, Dr. R. Brown outlined two fundamental criticisms that had been addressed by him in a written submission. Firstly, he felt that the IEA treatment of vulnerability failed to recognize that seabirds are inherently more vulnerable than other groups of fauna.

73. **Comment noted. However, this may reflect Dr. Brown's own research interest in seabirds.**

74. Secondly, Dr. Brown criticized the vulnerabilities ascribed to various seabirds. In his estimation, the vulnerabilities in Section 6.7 seem to be based not only on wrong criteria, they are also just plain wrong. To provide examples, Dr. Brown cited the experience with oil spills from the Irving Whale and the Kurdistan where the birds worst hit were eiders inshore and auks offshore. Kittiwakes on the other hand were not seriously affected.

Dr. Brown felt that factors other than pelagic features should be taken into account in assessing vulnerability. He suggested the following classification of vulnerabilities:

- Kittiwakes - slight to moderate
- Eiders - moderate to heavy
- Auks - heavy
- Razorbills - severe

Dr. Peter McLaren indicated his concurrence with Dr. Brown's comments. While he did not agree completely with Dr. Brown's ranking of vulnerabilities, he felt the section was overly simplistic.

74. Comment noted. However, sensitivities were not based solely on behavioural criteria, but also on breeding biology and distribution. The two shipwreck incidents gave no information on how rapidly populations recovered after the spill.

75. As a further point Dr. Brown criticized the discussion of sublethal effects of oil on birds. Oil will not only affect birds' energy balance, it can reduce the fertility of embryos, delay ovulation, stunt chick growth, and interfere with ability to excrete salt. Dr. Brown felt these impacts should have been dealt with in more detail. Dr. McLaren commented that it would have been consistent and more appropriate for this section to consider impact assessment of categories (shorebords, waterfowl) rather than deal with each species.

75. Criticism accepted. The work of Peakall and his co-workers could have been quoted more extensively in the discussion of the effects of oil on birds.

76. There were two criticisms of maps. Dr. D. Stone felt species names should have been given rather than abbreviations, and that names of localities should have been shown. Dr. Brown was critical of the legend system used in offshore distribution maps.

The group concluded that, for this section, a great deal of re-writing was in order.

76. Comments noted.

Marine Mammals

77. Following his presentation, Dr. R. Davis was asked what he saw as further information needs. He felt two studies were necessary and feasible:

- baleen whale surveys to document numbers, movement patterns and concentrations; and
- try to tie in as much information as possible on why animals are where they are.

The latter study would require a ship based survey that also looked at oceanographic processes.

77. **These whale studies are not an industry priority at present. Forthcoming OLABS work may provide some of this information.**

78. Mr. R. Wiseman expressed concern that writers of the marine mammals section failed to access or reference the grey literature on seals that has been produced by DFO and related agencies.

78. **Why has this information never been published more widely in the refereed ("white") literature?**

Social Conditions

The group decided not to address this section.

Oil Fate and Effects

Ms. N. Sutterlin introduced the section pointing out that her focus had been on the effects of oil on the biological environment, rather than slick trajectories or blowout scenarios.

79. The review of oil toxicity studies for various species tended, of necessity, to be academic and related to laboratory experience. This limits the application of results to the real world situation, and hampers any effort to predict impacts. As a result Ms. Sutterlin suggested that perhaps the section should have been deleted. The discussion turned into a debate on the merits of inclusion of this section. The chairman agreed to report the lack of consensus reached and that confusion and disagreement existed over the purpose and usefulness of including the Fate and Effects Section in the IEA document.

In considering the scenario that was presented, the group appeared to reach a consensus that, while it may not be accurate and certainly has limitations, such an exercise is useful in giving the reader an example of what one will find in contingency plans.

79. **It is unfortunate that lack of consensus precluded a rigorous review of the most crucial section of the IEA. Without an analysis of impact, there is no point in producing an environmental assessment.**

GROUP II DISCUSSION - Mr. Lawrence Coady, Chairman
- Ms. Gerry Collins, Rapporteur

Seabirds

Mr. Coady opened discussion by stating his opinion that the surveys described have represented excellent pro-

gress over the past two years. Further work had been advocated by LRAC on ducks and has been completed.

80. A question was asked as to the potential impacts on shorebirds if an oilspill came ashore. There are no well defined "colonies" and the birds are widely distributed so impacts would probably not be severe (P. McLaren).

80. Not quite accurate. Virtually the entire population of some arctic breeding species may pass through Labrador during migration.

81. There was some discussion on the types of impact caused by oil, e.g. fouling of feathers, ingestion of oil, oiling of eggs, aversion to fumes. It was pointed out that fouling impacts would likely be most severe, for example on alcid colonies at Groswater Bay and on guillemots.

81. See response 75.

82. Dr. P. McLaren was asked his opinion on future research needs. He replied that more baseline information is needed. More importantly, a process oriented approach is now necessary in order to explain bird distributions in terms of physical oceanography.

Ms. B. Fowler cautioned that having only one year's data on birds gives no indication of the relative health of populations.

Mr. Coady asked whether an integrative approach is planned to bring together all seabird data collected by the EAMES and OLABS programs in order to give an overall picture of distribution over the Labrador Sea. Dr. McLaren agreed with the usefulness of such an approach but pointed out it is not a priority item at this time.

82. Although interesting, such studies are not presently an industry priority.

R. Percy asked about the effect of dispersants on birds. Dr. J. Payne noted that in laboratory situations some dispersants dissolve natural wax in bird feathers.

Marine Mammals

Mr. Coady opened the session by referring to written comments prepared as a result of the DFO review (Appendix 2). He then solicited comments from the workshop participants.

83. Mr. D. Hardie commented that there was no attempt to interpret the data that was presented. This needs to be performed (e.g. for distribution maps of species) rather than present a straight regurgitation of data.

83. Comment noted. It is doubtful that, until ongoing OLABS work is published, there is enough information to publish distributional maps for marine mammals other than hooded and harp seals.

84. Ms. B. Fowler commented that, contrary to what was written in the text, information on numbers and population dynamics of (harp) seals had increased because of the publicity surrounding the whitecoat harvest.

84. Agreed.

85. Mr. L. Coady commented that the distribution of the resident ringed seal needs further study. R. Davis replied that ringed seals inhabit fast ice and are hence not likley to be affected by an oil spill. Bearded seals are more susceptible to impacts from the oil industry.

Mr. Coady noted that research on the inshore-offshore distribution of harp seals and their movements in relation to ice and food supply warrant attention. As an example, fishermen at Nain may have a bumper catch of seals one year followed by none the next, neither of which reflects the status of the resource. Dr. Davis replied that more information on seal distribution patterns is available but not to the extent required.

85. OLABS may provide some distributional information on ringed and bearded seals.

86. Discussion shifted to the means whereby work done subsequent to the IEA will be made available to the public. Mr. Hardie pointed out that the material will not appear in IEA format but in a variety of formats, all of which could be available to the public. Both Mr. Hamel (LRAC) and Dr. Columbus (LIA - Labrador Inuit Association) requested a written record from Petro-Canada of all studies initiated since the IEA was written.

86. A list of OLABS studies appears in this document.

87. Mr. R. Percy suggested wider circulation of the Executive Summary as a means to inform the public of studies undertaken by OLABS. Mr. Coady disagreed, saying this was a poorly written section. N. Sutterlin suggested a re-write and then public distribution.

87. The executive summary has been re-written and is being circulated to the public.

88. B. Fowler noted the availability of baseline data from the Blue Dolphin cruises in the early 1950s. Historical documents on Natural History are another potentially rich source that should be examined.

88. Historical records are anecdotal, and are generally of little use in compiling distributional maps or in assessing population changes through time.

89. Dr. Davis noted that little information exists on the effects of oil on marine mammals, and that studies presently underway aren't sufficient for use in contingency planning. For example, whales are dependent on dense concentrations of forage species, and a knowledge of this relationship is needed to develop contingencies.

89. It is true that relatively little is known of the effects of oil on marine mammals. However, it is difficult to imagine how this information would be used in deciding when, where and how to deploy materials and manpower during an oil spill.

Social Conditions

90. The brief discussion on this section was led off by Dr. K. Columbus. He noted that studies on social conditions have tended to be descriptive rather than scientific. He recommended that future studies be undertaken with a statistics oriented approach.

90. Comments noted. The implication seems to be that "numbers crunching" is always good science, while a verbal description isn't.

91. A key area of future study is the identification of stress sources, for example the changes in community economics that can accompany resource development activities. Socio-medical aspects of the communities with regard to development of the oil resource and the changes it will bring to these communities is another area where further research is necessary.

The provincial approval system and its socio-economic requirements were discussed briefly.

91. Petro-Canada agrees that this information would be necessary for production. During the present exploration phase, the drilling fleet operates offshore and the main support base is in St. John's. Routine exploratory drilling is thus less likely to stress the Labrador social fabric in a profound way.

Oil Fate and Effects

92. Most of the discussion centered on drilling muds. Dr. J. Payne felt that, while impacts are localized, it is nonetheless necessary to develop simple modelling studies for monitoring purposes. D. Hardie noted that EMR has funded a research project on drilling muds. Such questions as dilution rates, types of material used, indicator species, heavy metal concentration and the validity of existing research on heavy metal contamination are being examined. He also noted that EMR has provided guidelines to Mobil for monitoring any production that will occur in the Grand Banks. Presumably, at the production stage there could be significant volumes of waste drilling mud released into the environment.

Mr. R. Percy suggested an examination of abandoned well-sites to determine heavy metals accumulation. Mr. Coady suggested that a "wait and see" attitude concerning drilling mud monitoring strategies should be adopted, considering the extensive research underway. Mr. Hardie agreed.

92. There is a large quantity of literature that indicates that acute toxicity of drilling fluids will not likely be a problem in areas such as the Labrador Shelf, where currents are strong and waters are relatively deep. Petro-Canada agrees that heavy metals should be monitored, and that production is likely to release more heavy metals than exploratory drilling, because greater volumes of muds are used.

93. Dr. Columbus referred to information brought forward at a recent conference on Georges Banks Oil Exploration where it was suggested that some of the drilling muds used in that area contained radioactive material. He suggested Petro-Canada monitor drilling muds to ensure against the inadvertent release of radioactive material.

The impact section of the document was considered briefly. Much of the impact prediction was generalized and not specific to Labrador. In large measure the impact section was based on literature review. The difficulty of describing impacts in the absence of a clearly defined project was pointed out.

93. Recommendations noted. It would be useful to know whether the radioactivity originates from mud additives such as barite, or from the formations being drilled. In the former case, it may be possible to use alternative sources of mud additives.

94. The need to include contingency planning information in the IEA was discussed in some detail with the eventual consensus that it's inclusion is not necessary.

94. Agreed.

95. The discussion moved to effects of hydrocarbons on the physical environment. Ms. Fowler criticized the absence of information on fate and behaviour of oil and gas under sea ice.

95. Incorrect. The behaviour of oil under sea ice is discussed in Sections 6.5.5 and 6.5.6 of the IEA.

96. In discussing the effects of oil on the biological environment, there were a number of criticisms of the approach taken. D. Hardie wished to be on record as saying that there is no information in the IEA which justified the conclusions reached in section 6.8 (Oil Spill Scenario for the Labrador Sea). He felt the document should not be assessing impacts on the basis of qualitative data.

Some participants felt the scenario section should be deleted from the IEA, however, Mr. Bain and Dr. Payne disagreed. They felt that, despite its shortcomings, it generated a good deal of discussion among scientists, and without this section the IEA is merely a literature review.

96. This sweeping generalization was obviously intended for dramatic effect rather than as a serious-minded criticism of Section 6.8. The conclusions reached in Section 6.8 are supported by the baseline data in Section 5 and in Sections 6.5 to 6.7 inclusive. It is true that the inferences of Section 6.8 are based partly on qualitative information such as behaviour, habitat preference, and general life history. However, quantitative information such as relative abundance, fecundity and generation time was also invoked when such data were available.

GROUP III DISCUSSION - Dr. Norman Williams, Chairman
- Ms. Katrina Hodgson, Rapporteur

Seabirds

97. The group felt there are major deficiencies in the seabird data base of the IEA. While it was felt that this section represented a good overview of information available at the time of printing, updated as well as more quantitative and detailed data, supported by maps, graphs and illustrations are needed for impact predictions and contingency planning.

97. Comments noted. Perhaps more cartographic information should have been included. However, with some groups, especially shorebirds and waterfowl, the existing information is still too limited to compile reliable maps.

98. Inclusion of the 1981 seabird studies by LGL could partially remedy this situation. Winter seabird distributions and activities for the entire Labrador Sea should be examined. Such information would be essential to predicting impacts for oil spills occurring under ice, as open water channels are potentially important feeding areas for seabirds residing in ice-covered waters.

98. Agreed.

99. The value of seabirds as a food to residents has not been addressed, although it is important in the assessment of oil spill impacts. Local hunting statistics could also assist in the interpretation of species presence. This could provide a helpful indicator for interpreting aerial counts.

99. Agreed. Perhaps the IEA could have used information from Brice-Bennett's (1977) Our Footprints Are Everywhere. Although this information is not statistical, it does give some idea of the location and importance of hunting areas.

100. The present level of information on seabirds is inadequate to indicate magnitudes and possible reasons for population variability. The parameters needed to predict seabird distribution have to be refined.

Mr. S. Akenhead suggested a possible correlation between the shelf break and seabird concentrations. Dr. P. McLaren confirmed that, where survey flight lines included the shelf break, high numbers of birds were observed in that region.

Dr. McLaren cautioned that the data on seabird colonies and distributions is so recent it is not possible to comment on the present state of health of these populations.

100. Some answers to these concerns may be provided by industry-funded studies that CWS is conducting at the Gannet Clusters and Hudson Strait.

Marine Mammals

101. Dr. N. Williams started discussion by pointing out that, up until the date of the IEA, there had been no data available on winter distributions of marine mammals, excepting only information derived from sealing and the former whaling industry. The opportunistic whale surveys, part of the 1981 seabird surveys conducted by LGL, do not provide adequate winter coverage so this data gap remains.

101. Comments noted.

102. The technical review prepared by staff of the Department of Fisheries and Oceans was referred to and the comments of Dr. D. Bowen and Dr. K. Hay discussed. They generally were not impressed by the marine mammal section and felt the part on whales was particularly weak.

102. Unfortunately DFO written comments did not specify the sources of additional information on whales that were missed. Surveys by Keith Hay of DFO provide significant new information on whale numbers (but not distribution) in Newfoundland-Labrador; these results were not published until 1982.

103. Some factual errors were pointed out, for example the statement on page 1-12 about publication of data on harp seals numbers is incorrect and should be deleted.

103. Criticism accepted.

104. The group felt that this section would be of no use as a support for contingency planning, as it lacked any distributional information.

104. Except for perhaps harp and hooded seals during whelping, there is little useful distributional information available. Most of the information in the published literature consists either of comments on habitat preferences, or of compilations of opportunistic sight records. OLABS information in Boles et al. (1980), Boles (1980) and Brice-Bennett (1980) is not detailed enough for mapping marine mammal distributions off Labrador.

Social Conditions

Mr. D. Karasiuk, as editor of the IEA, elaborated on the approach taken in Section 7. It sought to convey a basic description of life in the coastal communities and provide a tentative evaluation of how petroleum exploration might alter this lifestyle, including the opportunities that the petroleum industry might create. The threads throughout this section are:

1. that fisheries had undergone a very strong resurgence, and the fishery, not the petroleum industry, may be responsible for the ultimate economic turnaround of the Labrador communities;

2. a pluralistic lifestyle of resource utilization (fishery, hunting, trapping) has evolved and is functional in Labrador; and

3. the past boom-and-bust nature of ventures in Labrador may have influenced people to retain their traditional lifestyle rather than seek employment in the petroleum industry.

105. Section 7 is based primarily on a report by Mr. A. Williamson, a researcher with many years experience in the Labrador setting. Community descriptions were prepared by Mr. B. Leach. A minimum of editing was done. Mr. Karasiuk said that he had changed some comments but had tried to retain meanings. Ms. C. Michelin suggested that people read Mr. Williamson's original document since she felt that some of the interpretations of Labradorian life as presented in the IEA are quite inaccurate.

In response to Ms. Sutterlin's statement that, as a biologist, it was presumptuous to say whether these are accurate interpretations of the lifestyle, and that there is no basis for a biologist to make such judgements, Ms. Michelin replied that it is the business of all the participants to make that assessment, given that an underlying assumption of these sessions is that all scientists have some comprehension of what others are doing.

105. **Unfortunately, Ms. Michelin refused to clarify which interpretations she felt were incorrect.**

106. Dr. P. Smith and Dr. N. Williams expressed the opinion that, based on their experience, the IEA lacks an emotional perspective of the wants of the Labradorians, and there is no feeling of their psychology. Dr. Williams felt that this section does not convey the cyclical lifestyle as part of the social fabric.

106. It is unclear what kind of information would be needed to answer this criticism. The cyclical lifestyle of Labradorians was discussed in considerable detail in Section 7.2.4 of the IEA.

107. The need for public consultations, especially prior to final documentation, was expressed by John Bursey. A dialogue has to take place, and Petro-Canada is now taking a step in the right direction with planned public forums (C. Michelin). Dr. Williams suggested that perceptual surveys would be another appropriate forum of public input, but he cautioned that these be carefully worded to avoid biasing the responses.

107. Perceptual surveys could be useful in developing plans for production.

108. Mr. Akenhead felt that the importance of fisheries to the Labrador communities and future directions were not apparent in the IEA. D. Karasiuk stated that this had been addressed on a "humanistic level".

Mr. Karasiuk stated that "something we purposely did not become involved in were the problems associated with social upheaval that has been reported in parts of Labrador". In response to questions from Ms. Sutterlin and Dr. Williams, he said that there are very serious social problems that were not addressed because Petro-Canada did not feel that they were a legitimate part of the document: "If we neither induce nor exacerbate the problem... it is not particularly germane" and "it was not politic to address such social problems".

108. Invalid comment. Sections 7.2.2 and 7.2.4 of the IEA discussed the fishery as a significant part of the Labradorian lifestyle. Section 5.14.3 provide considerable detail on the economic significance of the Labrador inshore fishery.

109. The group was of the opinion that all problems should be discussed: impacts (from oil exploration or development) super-imposed on such conditions could well worsen or alternatively alleviate them (N. Williams).

109. This degree of detail may be justifiable in an EIS for production. During exploratory drilling, the industrial impact on Labrador communities has centered around the maintenance of a secondary support base at Goose Bay and transit bases at Cartwright and Hopedale. Fewer than 50 Labradorians were directly employed during 1980 and 1981, out of a total population of approximately 6500 people. Thus, present low levels of onshore industrial activity probably do not justify the detail expected by the reviewers.

110. D. Karasiuk responded by stating that Petro-Canada had acknowledged that impacts exist (hence the Social Affairs Department) and that a better overview is needed. He said that if an explosion of activity was to take place, Petro-Canada's social and economic people would be expected to consult with Labradorians and representative groups such as LIA and LRAC. However, there is a deep frustration generally perceived that the oil industry is ignoring the people. Ms. Michelin shared the following with the working group: "One of (Petro-Canada's) people said to my face not very long ago that 'you're joking if you think you can change anything. When we're ready we will take over - we'll come in, we will put a site together with, if necessary, 13,000 people. Your opinions, whether they're useful or not, don't matter.'"

This attitude has been perceived elsewhere. Dr. P. Smith related that a high-ranking civil servant, at a University Symposium on Arctic Environmental Protection, was asked point blank if a company made up its mind to go into the Arctic based strictly on environmental and not on socio-economic issues, could we actually stop them. His reply was "no, they'll go right ahead".

110. Petro-Canada is concerned about the frustrations from which these statements arise. Both statements imply that native people feel powerless to influence decisions affecting their lives. Petro-Canada hopes that the sources and possible solutions for these frustrations will be discussed at a public seminar that will be held at Goose Bay in November 1982.

The conclusions reached by the working group were that while readable, the information on social conditions is inadequate and does not give a view of coastal Labrador life that would allow assessment of the impacts of oil and gas activities. The present treatment falls between two schools: it does not present hard information, yet it doesn't give a full portrayal of Labrador life.

2.3 CLOSING PLENARY SESSION

With the convening of this session, a panel comprising the three chairpersons presented the conclusions of each of their workshop groups. This presentation was based on the "brainstorming" Session D and each chairman has, in essence, provided a report on the discussion that took place during that final workshop session.

This was followed by a general discussion of these presentations plus comment on the document and the review process.

Concluding remarks were provided by B. LeDrew, and Dr. W. Speller closed the seminar.

2.3.1 Panel Presentations - Group I, II, III

Group II - L. Coady

Mr. Coady opened the session by complimenting Petro-Canada on the multidisciplinary approach taken to the seminar as evidenced by the range of agencies represented in his group. Since the IEA was written, the data base for the region has doubled, particularly with respect to ice, shorelines, seabirds, and physical oceanography. Despite the dated nature of much of the IEA, all group members agreed it was invaluable as a starting point from which hypotheses for future research could evolve.

Each section of the IEA was discussed with respect to its merit and its shortcomings, and recommendations for further research were made.

111. The Executive Summary was felt to be one of the weakest sections in the report, as key sensitivities (e.g. marine mamals, cod larvae) were insufficiently profiled. Facts extracted from the text did not reflect the unique features and problems characteristic of Labrador.

111. The executive summary has been rewritten with these comments in mind.

112. The section on Physical Oceanography was commendable and research planned, as well as that already carried out, appears to be well under control. Unfortunately, no attention was given to explaining the relevance of Physical Oceanography to impact prediction. Although not the purpose of the IEA, this failure could limit an understanding of the practical applications of the material presented.

112. Incorrect. The discussion of slick trajectory modelling relied on data on winds and ocean currents. Oceanographic parameters were identified as major influences on the behaviour fate and persistence of oil, and these influences were described in detail.

113. It was recommended that there should be direct application of physical oceanography to specific features, e.g. current studies in conjunction with iceberg drift modelling and seabed properties.

113. Agreed.

114. Physical oceanography was discussed in relation to the nearshore aspects. It was explained in the workshop session that physical oceanography has little to do with movement of oil to the shoreline. Nearshore movements of oil are more dependent on onshore winds. This point should have been made clearly in the IEA. Studies of nearshore movements of oil in relation to meteorology were carried out after the Kurdistan incident. This information is available and should be looked at. NOAA has developed a portable system known as CODAR which has significant inshore applications in terms of detecting surface current movements and generating real time maps. This system could possibly be used in the nearshore zone of the Labrador Sea.

114. Comments noted. A more careful reading of Section 6.6.3 of the IEA would reveal how winds, tides, waves, ocean currents and ice together affect the impact and persistence of oil.

115. Although it is necessary to have winter data, it is realized that winter studies are costly and logistically a problem. Industry will not fund these studies when there are no winter operations underway. More wave data is needed. Although costly to obtain, the information is necessary to develop a better understanding of physical oceanography.

115. These studies could have some use if the drilling season were to be extended; high autumn sea states and winter pack ice militate against late-season drilling. Thus winter oceanographic studies are not an industry priority at present.

116. The onus is on resource agencies to extract as much information as possible from the available data base. For instance, Petro-Canada need not be expected or relied upon to evaluate fisheries implications from the physical oceanographic data base when DFO is in a better position to evaluate the information more thoroughly from a biological perspective.

More work is needed to understand the eddies at the shelf edge.

116. **Agreed.**

117. The Strait of Belle Isle and Hudson Strait have been insufficiently covered with respect to physical oceanography, yet are considered part of the study area.

117. **Work in Hudson Strait would have little application for spill response, because the area is "upstream" from the area of oil exploration. Work in the Strait of Belle Isle would be more relevant.**

118. DFO has obtained physical oceanographic data collected by the Blue Dolphin Expeditions in the early 1950s. This material is being analyzed and will be added to the MEDS data base.

118. **This is not an industry priority, because similar information is being collected under ongoing industry programs.**

119. Chemical Oceanography was briefly discussed. It was recognized as a relatively new discipline. Its relevance was questionable and the conclusions conjectural. The MEDS data should have been examined. No analysis was made of such data, but instead only a synthesis of the current literature was made. The work needs to be extended to deeper depths, the offshore, troughs, the slope and fjords.

119. **Petro-Canada was not aware that these unpublished data existed. It hopes that government will soon publish this information. Information on chemical oceanography, except for that on background concentrations of heavy metals and hydrocarbons, has little application to design, monitoring or spill response, and so is not an industry priority.**

Microbiota

120. Dr. J. Bunch has been funded under OLABS to do Microbiota studies in conjunction with BIOS at Cape Hatt. The applicability of BIOS studies to the Labrador Sea was questioned. Representative sampling of these waters is needed in addition to the BIOS work.

120. **In fact, the BIOS study was located on Baffin Island because Labradorian public interest groups did not want an experimental oil spill on their coastline.**

Primary Productivity

121. A long term systems approach is needed, with emphasis on the percent contribution of the ice biota, phytoplankton and macrophytes to primary productivity.

121. **It is difficult to imagine how this information would improve design, monitoring or spill response. This is not an industry priority.**

Zooplankton and Ichthyoplankton

122. As with phytoplankton, there's more emphasis on numbers than biomass and seasonality. A knowledge of trophic relationships is completely lacking.

122. **This is a deficiency of the literature. Again, the applicability of this information is difficult to see.**

123. Since a long term study is unrealistic, key relationships need to be identified in the ecosystem. Indicator species need to be identified for impact assessment and monitoring purposes.

123. **Agreed. The IEA proposes cod eggs and larvae as possible indicators.**

Fish and Fisheries

This section is somewhat weak. The level of detail throughout is insufficient. There are a lot of key sensitivities, such as larval fish concentrations which weren't addressed. There is no information on oil-fishing industry interactions (e.g. potential areas of conflict or reference to historical situations such as the North Sea). Questions pertaining to resource utilization and potential impacts of an oil spill on the industry (e.g. fish tainting) require further attention.

Seabirds

124. Some excellent work was done by LGL in the offshore and by Canadian Wildlife Service (CWS) on the coast. Emphasis should now be placed on ecological aspects, on process, and on such things as relating seabird distribution to physical oceanographic data. The latter shouldn't be too difficult, as there exists an adequate data base in both disciplines.

Physiological impacts of oil on birds may be a future study requirement, although it is realized a lot of work has already been published on this topic.

124. Perhaps this is a government priority.

125. Seabird-fish interactions need to be further studied as they are not yet adequately understood.

125. Probably a government priority.

Marine Mammals

126. Basic information on harp seal ecology, population size, and reproductive aspects was not referenced in the text. There were no diagrams and very little was done with the data which was presented.

126. Criticism accepted.

127. There is not enough basic information on marine mammals for contingency planning purposes. This is necessary as marine mammals are of prime sensitivity. DFO is studying harp and hooded seals, so future industry research should concentrate on ringed and harbour seals. The inshore-offshore distribution of harp seals was also judged to be an area of needed study. Cetacean distribution offshore is not well understood, although it is realized the data is difficult to collect.

127. Baseline population studies on harp, ringed and harbour seals are also within government's mandate, despite financial constraints.

Social Conditions

128. This section was generally well presented and contained an adequate amount of background information. The only major shortcoming was found to be the lack of a scientific, statistics-oriented approach to information gathering. This kind of approach is recommended for further on-going research. LIA has undertaken studies which are aimed at identifying key impacts associated with development of the oil industry. These studies have adopted a scientific rather than a purely descriptive approach. Close contact should be maintained with LIA to keep abreast of study results.

128. Petro-Canada is most interested in examining LIA's results, when these become available.

Fate and Effects

129. Much of the discussion in this section centered around the topic of drilling muds. EMR has contracted Environment Canada (DOE) to undertake a major review which will eventually lead to guidelines for drilling mud disposal. The DOE study will involve dilution rate, types of

material, indicator species, heavy metal contamination, bioavailability and sub-lethal effects.

Mobil is developing a monitoring strategy for drilling muds. General concerns focus on heavy metal concentrations and bioavailability.

A conference dealing with offshore exploration on Georges Bank was held a few months ago and some interesting findings regarding drilling muds were presented. These results should be examined thoroughly when they are made available, and their applicability to the Labrador offshore situation determined.

129. **Comments noted.**

130. Impacts associated with drilling muds are localized and considered to be of no great consequence, according to most studies. Effects should nevertheless be monitored.

Many well-site surveys have not taken advantage of the opportunity during sediment sampling to undertake heavy metal analysis or invertebrate studies. This type of research could "piggyback" on to what is already an extremely costly procedure. As the agency which sets requirements, the onus rests with COGLA to ensure maximum benefit is obtained from well-site surveys.

130. **Ambiguous comment. There is enough information on acute toxicity of drilling muds to dismiss this as an environmental issue off Labrador; however chronic contaimination by heavy metals could merit monitoring studies.**

131. There was some concern about the definition of accidental versus operational spills in the text. The definitions should be clarified.

131. **As noted in the IEA, this is described in the Contingency Plan for Labrador.**

132. While the chemistry of oil was discussed in the text, it would have been useful to provide a summary table showing the various biological, physical and chemical degradation processes and the breakdown of oil over a strict time period.

132. **This detail is almost impossible to supply, because each oil is unique; oil chemistry (and thus oil weathering) varies greatly from reservoir to reservoir. At the time the IEA was being written, there was no information on the characteristics of oil from anywhere in Labrador, including North Bjarni.**

133. There is no information in the document which justified the conclusions reached in the Impacts section. It was advocated that the Scenario section be left out of the document as it was unrealistic in relation to the information presented.

133. See response 96.

134. There was some discussion as to whether a contingency planning section should have been included in the IEA given the heavy reliance on such material in EARP Hearings on Davis Strait and Lancaster Sound Exploratory Drilling Proposals. It was eventually resolved that this was not necessary.

Concern was expressed over the impacts of counter-measures, e.g. the impact of a dispersant on the eco-system. Studies required to assess such impacts are being undertaken under the BIOS program.

134. Agreed. This would be a needless duplication of information.

Geology

The geology section was thorough. The onshore geology descriptions were more than adequate, however, their relevance in understanding the offshore situation was questioned. The composition of offshore surficial sediments, on the other hand, is of great interest to ocean engineers, physical oceanographers, and biologists in terms of benthic communities and groundfish distribution, and to operators who are drilling.

Shorelines

The information on shorelines is dated but Dr. J.M. Sempels gave an excellent update on current research. Work on shoreline classifications and the development of a computer system in support of an operational response to oilspills is underway. Some aspects of shoreline research, such as resource harvesting, have yet to be carried out. It was questioned whether the physical analysis of shorelines should be extended to include biological criteria. Dr. Sempels thought this would be a waste of money, but it was felt by some that this was necessary.

The ranking of shorelines to indicate whether one deserves greater attention than another in the event of a spill was not felt to be a useful exercise. This should be done on the basis of circumstances which prevail at the time of any spill. Shoreline sensitivity information is being collected by the province and is

tied into compensation schemes. A co-ordinated effort with provincial personnel is encouraged.

Shoreline classification schemes form a tremendous planning base in the event of a spill, but the group questioned whether the technology would ever exist to respond to such information in an effective way.

Geotechnical Hazards

135. The section on geotechnical hazards was poorly done. The information presented was very general. The literature references were almost all from the Gulf of Mexico and Alaska. Problems presented in this literature often do not exist in offshore Labrador. C-CORE, Ocean Engineering (MUN), and NICOS are doing geotechnical work. Strengthened liaison with such local groups is recommended. The most significant data gaps were felt to be the lack of information on site specific surficial sediments. Opportunistic observations of iceberg scouring should also be carried out.

135. Criticisms accepted.

Ice and Icebergs

The ongoing research on ice and icebergs appears to be excellent. While there is information on numbers and sizes of icebergs from the banks, there is unfortunately little information on troughs, the edge of the bank, and the inshore. The research has been carried out only in open water. Lack of winter research reflects industry priorities.

136. It is recommended that Ice and Iceberg researchers form liaisons with local groups (NICOS, Ocean Engineering (MUN), and C-CORE).

One criticism registered by the resource people who reviewed the sections on ice, icebergs, and meteorology, was that AES is not adequately meeting its responsibility in provinding information. The initiative must come from regulatory agencies to ensure that such necessary information is available.

136. Agreed.

Meteorology and Climatology

The inshore, offshore, and that area on the banks which is being drilled did not receive adequate attention. Mr. Thompson said these data gaps were due to the insufficient number of weather stations in the area. A network enhancement of meteorology stations is recommended.

The most pressing information gap was found to be the lack of site specific meteorological information in the intermediate zone where drilling is taking place.

Group I - Dr. D. Stone

137. The group had a fundamental problem in understanding the purpose for which the document was written. It was, therefore, difficult to know whether each section had fulfilled its objective. The document is out of date in almost every section and the data are of questionable use in contingency planning.

Information contained in the sections on Geology and Shorelines was adequate and the section on Oceanography was well received.

137. See the summary response for a confutation of these sweeping generalizations.

138. The fisheries section was heavily criticized, particularly the information presented on cod stocks. Serious criticism was given to the section on birds. Species vulnerability according to life history was not addressed, and many portions of the field guide descriptions of the species were irrelevant. In the section on marine mammals, several inconsistencies were found. A lot of available information on seals was not tapped. Contrary to what the Executive Summary suggests, the seal hunt has stimulated seal data collection. The information presented on whales is misleading and, in some instances, incorrect.

The information tabled on drilling muds in the section dealing with fate and effects did not meet with any criticisms. The group consensus on spill trajectory modelling was that the information is of value, but must be heavily qualified. Research is needed to evaluate contingency plans. There are no major concerns with day-to-day activities, but it is necessary to understand what the consequences of catastrophic events will be.

An attempt was made to rank study requirements within the disciplines as set out below.

138. Comments noted. Most have been answered already.

Session A

139\. 1(a) In the Physical Environment Section, studies of surface currents should be undertaken.

(b) Work on ice climatology and the freezeup process will be necessary, especially if the drill season is extended by using semi-submersibles.

139. This information can be compiled from existing sources.

140\. 2. Understanding the wind field in relation to short term trajectory forecasting for icebergs is recommended.

140. This should be "the wind and current field".

141\. 3. A better understanding of how to do long term seasonal forecasting for icebergs is also recommended.

141. Agreed.

142\. 4. A process must be developed for age determination of iceberg scours in order to assess the amount of iceberg traffic in a given area.

142. Agreed.

Session B

143\. 1. Research on hydrocarbons and their effects on the lower trophic levels is needed.

143. Agreed. Although useful in preparing assessment documents, little of this research would have a practical application to design, spill response or monitoring.

144\. 2. A synoptic overview study of chemical, biological, and physical oceanography with respect to cod stocks, birds and marine mammals is recommended, i.e. what gives an area preference for marine life?

144. This supports the IEA's recommendation for the "cod larvae study".

145\. 3. A long term study to examine the key trophic interrelationships which would be impacted is recommended.

145. See response 143.

146. 4(a) Baseline information on marine sediments should be collected.

146. Ambiguous. What <u>kind</u> of information? Texture? Distribution? Heavy metal concentrations? Hydrocarbon concentrations?

147. (b) Nutrient requirements for the oleoclastic microbiota should be studied.

147. Bunch (1979) has provided much of this information for southern Davis Strait.

148. 5. Further studies should be carried out on the northern cod stocks and on other commercially valuable species to identify the time and space in which spawning occurs.

148. Agreed. A DFO responsibility.

149. 6. Studies concerning the effects of sinking oil on benthos and those studies which would identify benthic indicator species in the nearshore zone for monitoring purposes are recommended.

149. Agreed.

<u>Session C</u>

150. 1. Good winter coverage is needed on bird distributions to aid in contingency planning should an accident occur later in the season.

150. Agreed. OLABS surveys should provide preliminary information. They may be no practical application of this information, however, because of limitations of existing spill response technology.

151. 2. Further information is required on the distances to feeding areas from the bird colonies and on why these feeding areas are so attractive.

151. Agreed.

152. 3. Further work on numbers and distribution of marine mammals over the Labrador Sea needs to be performed, so that impact predictions will be more accurate.

152. Agreed. 1981-82 OLABS survey data may meet part of this requirement.

153. 4. The north/south migration of harp and hooded seals requires further study.

153. 4. The north/south migration of harp and hooded seals requires further study.

153. Agreed. A DFO responsibility.

154. 5. It is necessary to define areas of importance for marine mammals in order that these areas be known in the event of a spill.

154. Agreed. Real-time survey data would be more useful.

155. 6. The commercially important coastal ring seal needs to be studied thoroughly.

155. Agreed. A DFO responsibility.

Group III - Dr. N. Williams

The chairman observed that his comments would address some of the philosophical aspects of impact assessment.

156. It was unfortunate that Mr. Sempels' work was in the contingency document but not the IEA. Coastline mapping is a useful tool in impact assessment and therefore, should have been included in the IEA. Overlays of biological variables and human resource utilization may be added to the coastline maps to give a complete picture of the region.

156. The coastal mapping project was not complete at the time the IEA was being written. Petro-Canada intends to map features that are important to people and to the biota data utilization in its mapping, when the project is complete.

157. A number of questions were raised as to whether fundamentals of the geotechnical discipline were in place. Though not important in terms of exploration, it will be important when production takes place. It is necessary to start collecting baseline data now so that the data base will be in place 15 to 20 years from now.

157. It would be more appropriate to collect the geotechnical information necessary for production if and when a firm decision to go ahead with production is made. This information is costly to obtain, and to date, commercially exploitable reserves of hydrocarbons have yet to be found off Labrador.

158. Present knowledge of ice is inadequate for conceptual design of a commercial development, and yet this is the single largest danger to such a development. The group endorsed all future ice studies.

158. Agreed.

159. It is hoped that all updates and corrections to this and other sections are made available in the proceedings so that everyone has access to the information discussed in the workshops.

159. Done.

160. The bureaucracy can hinder the operator in collecting climatological information, particularly in making use of the remote weather stations. A strong recommendation is made to government to assist industry in the acquisition of that data, and to distribute the data within a reasonable time frame.

160. Petro-Canada strongly agrees.

161. Petro-Canada is interested in the upgrading of sea state observations. These should be standardized as much as possible throughout the industry.

161. Agreed. COGLA is perhaps the most appropriate agency to enforce these standards.

162. The Zapata Ugland, when stationed on the Labrador Sea, collected information on icing of the superstructure. This should be closely examined.

162. Agreed.

163. Currents were identified by the group as the driving process that everything in the food chain at one time or another keys into. Present current studies should be accelerated. If the information is studied effectively, shrimp, cod larvae in the trough, and seabird distributions will be seen to correlate with currents. It also has important implications in terms of drift (e.g. icebergs, and oil). In summary, water current information should be correlated with information on ice, atmosphere, animals, and oil distribution patterns. Water current information should also be differentiated by depth.

163. Agreed. This might be a useful area for co-operative studies by government and industry, as described in Section 8 of the IEA.

164. There was insufficient information in the Chemical Oceanography section, although the information presented was acceptable. The two sets of data collected however, are separated in time and space. Group III agreed with Group II in that there should be a synoptic study involving physical driving forces and nutrient exchanges. Nutrient levels and interactions require further study.

164. **The deficiency is a weakness of the published literature, not of the way the IEA quotes the literature. Though Petro-Canada supports these studies in principle, they have little direct application to design, spill response, or monitoring.**

165. Primary productivity in terms of the epontic community, the algae and the macrophytes were not given comprehensive treatment. Further work is required if any chain reaction effects are to be predicted.

165. **Again, the literature is deficient here. OLABS work reports standing crop biomass, not productivity. The meaning of "chain reaction effects" is unclear here.**

166. Mr. J. Barrie's nearshore benthic studies were quite good and lent themselves well to a biophysical approach. These need to be extended.

The epontic community needs to be understood as it is a major component of primary productivity.

Further work is needed on the interfaces between oil and air, sea, ice, sediment, and land.

166. **Agreed.**

167. The information on fish stocks wasn't comprehensive or accurate. Group III wants criticisms of the document by DFO tabled, along with Petro-Canada's response. At the same time, many group members were impressed with the way the document read, and this is documented as well, in the DFO critique.

167. **This Contradicts Group III comments appearing elsewhere, which indicate a favorable response to this section, and which indicate that Group III spent relatively little time with this section.**

168. Data presented on the fishery are far from accurate. It is appropriate for government, industry and the private sector to be involved in joint studies in this area. There was no data presented on catch estimates per area, amount of gear per area, or the economic value of the inshore fishery. It is hard to make any impact predictions due to this lack of information. Studies are required to fill these information gaps.

168. **The studies recommended here are clearly a DFO responsibility. Note that Table 5.25 of the IGA presents data on landings and landed values for the inshore fishery.**

169. The section on birds was missing some of the important tables and data from one of the primary component studies. This study wasn't cited very frequently. In terms of critical areas and times, however, there is a table in the document which has started to address these elements. The fine studies by Dr. P. McLaren and his group will round this out. In summary, these bird studies have established baseline data. It is important now to develop studies which will be used for impact prediction and monitoring.

169. Vague. Specify which of the primary component studies is referred to here.

170. The section on marine mammals has many shortages, but DFO has already dealt with these, so not much time was spent on the section.

170. Except for comments on harp and hooded seals, the DFO commentary was too general to be useful here.

171. Not much time was spent on Oil Fate and Effects. It was agreed that the technology doesn't exist to clean or retain a spill in terms of a catastrophic or even an operational spill.

171. Perhaps this sentence was written for dramatic effect - to state that there is <u>no</u> technology to deal with any oil spill. The comment is either misleading or indicates a limited understanding of the technology that already exists.

172. Concern was expresed that laboratory studies on oil and drilling mud toxicity aren't appropriate to the field situation, and that the synergistic effects of toxic elements aren't known. The BIOS study will hopefully answer some of these questions, yet it is wondered how applicable the findings are to a more southerly situation.

172. Inaccurate. Recent literature has described several field studies of the effects that whole muds have on marine ecosystems during drilling. See the <u>Proceedings of the Symposium on Research on Environmental Fate and Effects of Drilling Fluids and Cuttings</u> held January 21-24, 1980 at Lake Buena Vista, Florida.

173. The section on Social Conditions was unacceptable. The document makes suggestions as to how Labradorians can make their needs known, and yet there appears to have been a lack of input from these people.

173. The second sentence is incorrect. The IEA pointedly <u>avoids</u> telling Labradorians how they should determine their future.

174. A social attitude survey, where questions are structured to see how the impacts of oil production are perceived, should have been performed. The pluralistic economy needs to be looked at in terms of its importance to the annual budget of a family.

174. Much of this information is being gathered in a household survey of labour availability and barriers to employment, now underway.

175. In the Impacts Section, the definition of impacts is quantitative, whereas the level of measurement in the field is not. As there is little good information on population sizes, it is inappropriate to talk about percent impacts on these populations.

175. Incorrect. The rating of impacts is essentially qualitative, and is based on behavioural, life history, and distributional data. Quantitative distributional data were used, when available, in a "none/some/lots" semi-quantitative manner.

176. The developer should model scenarios, either schematically or mathematically, where the variables are changed and the outcome of each situation may be looked at. This would be in anticipation of production.

176. Scenario modelling of this sort is in its infancy. One such modelling project is being funded by the petroleum industry through COOSRA. However, population fluctuations of only a few species can be simulated at a time with existing models.

177. A comment should be made in the proceedings that the scenario section in the IEA is not appropriate for the purpose of oil production. A feedback loop for the scenario with input based on economic, ecological, operational, and mitigative factors would be necessary. As the operation becomes more streamlined, the scenario can be finely tuned.

177. It is true that the IEA is primarily concerned with exploration. It would be worthwhile to attempt production scenarios only <u>if</u> and <u>when</u> economically exploitable reserves of hydrocarbons are found off Labrador.

178. The synoptic studies on taxa should be based on the projected severity of the impacts. The organisms and communities which would be slightly affected shouldn't receive the same attention as those which would be moderately or severely affected.

178. The meaning of this paragraph is obscure.

179. The group was concerned that dispersants were not included in the Mitigation section. There is inadequate documentation on the effects of dispersants on organisms. As technology advances dispersants may be more widely used, so this information is necessary.

179. Agreed. BIOS should provide much valuable information on the effects of dispersant/oil mixtures on organisms.

180. Indicators are going to be required, but to have them, we have to understand the system and how it returns to the similar states. Only then will those indicators be effective tools in monitoring impacts. This will take the best minds and the most creative people to tackle this problem. In terms of assessments and monitoring, monitoring is the weakest aspect of the system. Mitigation can be suggested intuitively, but it is not known whether such suggestions will work. Indicator species may be suggested, but these may decline naturally because of annual variability rather than as a result of impacts.

180. Motherhood statement, but agreed.

Group III makes the following general recommendations:

181 1. COGLA program requirements should be discussed with the service and government agencies before these requirements are imposed on the developer.

181. Petro-Canada strongly agrees.

182. 2. AES and MEDS programs should integrate their efforts. This would avoid duplication and facilitate distribution of the data, e.g. the EAMES program - some studies within this program have provided answers for other studies. This is a good example of a tailored, integrated approach.

182. Agreed.

183. 3. Integrated studies are a necessity. Planning, implementation, and reporting should be conducted in concert in order to:

1. avoid duplication;
2. better manage economic and other resources;
3. amalgamate smaller with larger studies;
4. communicate the results in a meaningful synethesized manner.

183. Agreed. This point has been developed in Section 8 of the IEA.

184. 4. The setting of priorities for critical areas, times and species will be facilitated by using the coastline maps and overlaying the other resources. This will make contingency planning much easier.

184. Agreed.

2.3.2 <u>General Discussion - All Participants</u>

W. Speller:

Are there any comments from anybody in the audience who would like to add or subtract from anything that any of the chairmen have said, or add any additional points that they think are pertinent to what was said?

C. Michelin:

(Addressed to L. Coady)

Please clarify what you meant when you referred to the ongoing status of socio-economic studies.

L. Coady:

I referred to continuing studies over and above those which Tony Williamson of the Labrador Institute for Northern Studies has been doing in some areas. In fact, this work, which was carried out in conjunction with that done by LIA in the northern area, seems to me to be a very comprehensive data base at the moment. I am also advocating on the basis of some of the comments that came out in our group that, in addition to baseline information, we now need a more scientific approach to the sorts of facts that are gathered.

D. Stone:

I should point out that our workshop group thought that we didn't have anybody who was reasonably knowledgeable on this section of the document, so we avoided it completely.

W. Speller:

It seems to me that workshop group members were not willing to challenge their chairmen in terms of how they felt about the document and how they felt about the quality of the document and the types of studies that should go on in the future. As I explained to you, this exercise is part of an ongoing process. This document was proposed back in 1980. It's now 1982 and clearly what we've seen is a document which came out in the middle of a research program. We've certainly demonstrated that we've learned much more since the document was released. Certainly there's far more that could have been done in terms of integrating biological data. It's

always nice, of course, to look back and say to the guys who did this in 1980, you could have thought about this a little bit better and done a little bit better job.

I'd like to throw out a point and open it up to discussion. We are now facing new areas in Canada that may be opened up to exploratory drilling, and may require some sort of summary preparation where documents may be prepared in support of the activities going on. On the basis of what you've seen with this document and given where you think we are in terms of evolutionary process in impact assessments, I'd like to get the opinions of some of the panel members and other participants. If you had the choice, what would you be recommending in terms of what we should be doing, what sort of documents would you suggest, shall we say, for an operation in Hudson Bay right now, or in an area like (Foxe) Basin which is brand new? How should we approach this sort of thing looking at where we've been, where we are with these sorts of things, and where we're going in the future? If I could just leave that open to you and get some comments.

D. Karasiuk:

May I speak out please? I edited this document. I was very surprised when two of the three groups said that the fisheries section didn't have enough data. In my view there was more than anyone wanted to know about Atlantic cod. How much more do we really need to know to form an impact assessment, and, if so, has DFO been wasting its time for the last twenty years?

D. Hardie:

I thought that was pretty well explained. Fisheries is people involved in the fishery, not fish. We had no problems with biota, we have all kinds of stuff on that. It was the interactions with people.

D. Karasiuk:

No, there were two specific comments from two groups about the level of detail required in the section documenting the life history of fish. Now perhaps there's a large Russian literature that our consultants didn't tap for us. I would share the reservations expressed by many of the consultants as to how much of the Russian data one can even tap. This, in part, relates to how much of the Russian data one can trust. It's thought by some that, in fact, the Russian data are biased. Now I don't know if this is true. I think probably the people in DFO would have a better handle on the reliability of this information. What I have very serious reservations about is whether it's necessary to quote every author back to 1920 on Atlantic cod, when one or two studies may be all that's necessary to definitively express distribu-

tion, seasonal occurrences (whether its a behavior thing), or an inshore migration (when the fish would be most vulnerable). Now if we can't get this data after an exhaustive literature search, what has government been doing; and why is government now asking that industry fulfill government's mandate?

L. Coady:

I should defer to Henry Lear on the literature relating to cod, but I do have a couple of general comments. There's nothing wrong with the brevity in the section on cod. I think the problem is the troublesome omissions, misinterpretations and inaccuracies in the data. You're talking about the primary literature when you're looking for information. It was pointed out, I think by Joe Buckley, that there was a constraint in that the IEA drew its information from primary literature rather than the grey literature. For cod there is a tremendous grey literature, produced by NAFO (Northwest Atlantic Fisheries Organization) and CAFSAC and research documents which tie into our resource assessment function. When you look at what's available on cod on the Labrador Coast in the sense of contribution of the offshore (stock) to the inshore situation, or at the food and feeding studies which have become very extensive in the last two years, there's a lot of information that wasn't cited from grey literature.

D. Karasiuk:

Should industry be analyzing government files? I think it's part of government's mandate to publish.

L. Coady:

These aren't contained only in government files. The information is freely available. CAFSAC working papers are secondary publications accessible through DFO libraries.

H. Lear:

My major hangup on Atlantic Cod, with reference to the two Russian authors and the cod spotted north of 54° latitude is pretty specific. The Russians claim that 2-G,H (Northern Labrador) was the main location of spawning activity. I think the events of the 1960s really proved that this wasn't quite so. In our spring surveys up there, if there was a great spawning in the North, and they (the Russians) suggest that the spawning stock moves down during March or April, then we would pick up a great concentration of spent fish. Yet, in the latter part of March commercial boats pick up fish that are coming out from the shore, what we call mat age - mat age A and mat age B, which means we're dealing with fish that have not yet spawned but would probably release their eggs in two or three weeks. The Russian data was a bit

circumstantial in that they based it all on mainly egg and larval studies in the North gyre.

In light of recent literature, especially that relating to the influx of saltwater into Cartwright Channel, it would suggest that we aren't necessarily dealing with a North-South drift. It could be an East-West one, so the eggs might have been from the Harrison Bank or Hamilton Bank, or elsewhere. The major parts of Saglek and Nain Banks in winter time are too cold for cod. Further, there is little slope area to occupy on these banks, hence there are not any large spawning grounds available to these fish.

W. Speller:

I would really like to get on to the point I raised earlier. Where are we going in terms of these documents? I'd like to get some ideas from the audience. What do you see as requirements for these types of documents in the future? How might we better organize ourselves, how might we better produce these types of material and plan our exercises in future areas?

D. Hardie:

I think you have to be aware of how the existing government system is already in place, for example, the EARP (Environmental Assessment and Review Process) process. Until such time as that process is removed or changed, when you're dealing with a major activity or project, you're committed to that process.

W. Speller:

Are you suggesting then on the basis of that, Duncan, that we are looking to Initial Environmental Evaluation (IEE) or overviews, following through the system on the basis of which then, a regulatory agency like yourself would make a decision to require an EIS?

D. Hardie:

Yes. I think it is important to recognize that within the EARP process, there is no requirement for an IEA as it has been carried out in Labrador. The EARP process really only starts when you're talking about an IEE where it is the responsibility of the proponent to provide, not only an understanding or appreciation of the environment he is working in, but what the impacts can be, both on the proposed operation and from the operation on the environment and what mitigative measures he's going to put forward to reduce impact. Then, of course, we go from that initial stage up into a full EIS (Environmental Impact Statement) if the initiating agency feels that is necessary.

We're in a peculiar position within the EARP process because we are a regulatory agency (I'm referring to COGLA). We are not obliged to participate in the EARP process, however we do, and have been participating from a historical context. But I think we should remember that this environmental process is in place, and we have to respond to it to some degree. So, in essence, if you're bringing in the concept of impact, then you're looking at starting an analysis of a particular region at the IEE level, as outlined by the EARP process.

D. Karasiuk:

But we don't have to go through an IEE.

D. Hardie:

No, we can go straight to an EIS. But I should point out that the initiating government agency makes that decision.

B. Fowler:

We shouldn't be constrained by the way things are now, because a set of guidelines can be drawn up for each project that comes along. These processes are pretty general and very flexible. I think we need to talk about guidelines for putting together a document.

W. Speller:

Do you see us approaching something like this in a staged fashion where we can produce a document, for example an overview, that might be acceptable for exploratory drilling? If a discovery is then made, or one progressed to more intensive drilling or whatever, then improvements in the operation could be identified, as apart from going through an exercise like this.

B. Fowler:

I think we can start off looking at the purpose for the data collection. We can't say we need to know everything about the total world out there before we begin exploration or seismic activity, or we need to have a comprehensive understanding of the fate and effects of the type of oil which would be spilled. We want to know what the planned activity involves, what is really known about the environment. From that, one can identify what is needed to be known for the purposes of proceeding with this activity in a staged way. Once that begins, we come up with a document which (initially) focuses on what we need to collect to proceed with exploratory activity (and eventually production). We

should be able to pinpoint what studies are needed in a staged way.

W. Speller:

Do you see the main emphasis in the type of studies associated with exploratory drilling, as particularly those that would be in assistance of contingency planning or ensuring that a company did understand the physical environment and the biological environment?

B. Fowler:

I think that contingency planning is not your only purpose.

W. Speller:

I guess from the industry point of view it's certainly the thing that concerns us the most, and one of the things we would want to respond to.

B. Fowler:

There are many other parameters to consider involved with safety of an operation, design of systems, and planning which call for an understanding of the physical environment and operating conditions.

P. Smith:

Sometimes I get a bit confused with the terminology of the titles used, for instance "Initial Environmental" and the "Assessment" gives me a problem. I believe you (B. Fowler) made the comment that the document could be divided into at least two parts. I suggest that maybe what you're looking at in the first instance is an Initial Environmental Inventory of what's there, which contains the first part of this book. This inventory functions then as the initial data base upon which to build. We focus in on particular areas that need to be improved. At the same time we can do the impact studies based on that inventory and improve those as they go along in concert with the degree or stage of activity.

W. Speller:

I see what you mean. I can accept that in regard to the inventory, but the difficulty is that we have the regulatory agency which needs to make some sort of a decision to allow industries to be built or not to have them built, and it requires some sort of assessment. I would question whether the inventory exercise should be the topic of a supplement to something like this (the IEA) or a separate document. Further, who would do an assessment like that? Is that

something to be done perhaps by the environmental regulatory agency, like EPS for example, as well as AES, DOE, and SFO. Where does that sort of assessment come from?

P. Smith:

Well if I understand the comments that were made just a few minutes ago, there is no need for a report titled, "Initial Environmental Assessment".

W. Speller:

That's true. COGLA (EMR at the time) wanted the document, and we were prepared to provide it. There's no doubt about that. The point was we didn't want to get into the Initial Environmental Evaluation type idea and thus brought into the EARP process for the simple reason permission had already been given to drill.

D. Hardie:

I don't think that what you've gone through here is that much different from the suggestion of having the inventory on one hand and the parallel impact assessment exercise at the same time.

D. Karasiuk:

I'm curious about two separate trends that are evolving. One is the emphasis on pattern, that is, the distribution in time and space, and the other one is the emphasis on process, which indicates structure, food webs, interrelationships among what were thought to be disciplines. Now it seems that for contingency planning, perhaps you need to know patterns, but for assessments you seem to need to know something about process. I would like the feeling from the group about what the relative balance between the two should be. In the OLABS studies, LGL, for example, in doing aerial surveys, is looking strictly at pattern and distribution. Canadian Wildlife Service is looking at things like reproduction, assessing the quantity of natality and mortality. How much do we need to know about natality and mortality to do an assessment as opposed to just raw distribution?

C. Mageau:

Until you can comprehend the environment. Once you've done your inventory and have outlined the data gaps, then before you can get to an EIS, you should have filled out these data gaps. You have to attain a level of comprehension of the environment, and that comprehension may never be totally there. Then you get into the description of mortality, to the breakdown into very basic units. That's one aspect of demonstrating you understand what the environment

is. Then you have to prove you can operate within that environment. You can't just take the tactic of protecting the destructive parameters from the environment.

D. Karasiuk:

I'm asking a very serious question, and I think you're missing it, and that is to actually set about protecting the environment (protecting the drillship from the environment, and the environment from whatever the drillship has done). At what level of detail do you really need to know process, for example ecological relationships? Because, to really understand ecosystems, it would take ten years. Now, it's unlikely that anybody will embark on a ten-year study before applying to drill in a variable environment, which is always going to be sensitive. Are the kinds of things that are being affected such as ecological relationships, food webs, this kind of thing, a reasonable thing to ask industry to study as part of an environmental study, or is that something that is more properly done by the academic community and by government?

L. Coady:

You've pointed out something which was discussed in our group. It's extremely difficult to deal with trophic relationships. The options aren't very exciting - you either do nothing, or conduct a fifty-year study, neither of which is an acceptable action. It's a difficult question to answer.

D. Karasiuk:

I agree, but we need guidelines like that from government before we can proceed with Environmental Impact Statements like this in the future. The level of resolution that is required has never been made clear.

W. Speller:

I think that goes back to what Barbara Fowler has said, we need guidelines.

J. Payne:

Especially in reference to all statements by Don Karasiuk, how does he feel about the two major studies done in the U.S. and the U.K. which show no major ecological effects from oil? We should at least look at these oil studies. The implication of comments made here is that we're completely in the dark about any aspect of oil pollution. I'm just wondering what anybody in the audience feels about those two major studies? The U.K. study was three years in the making and all the overviews said basically, localized impacts were virtually a non-problem so perhaps we're not as badly off as we may be led to believe.

N. Williams:

I think a lot of people would agree that a blowout offshore would have a localized impact, and would be dissipated probably quite quickly. Most of the sensitive populations are generally not around the well heads. But inshore is a different problem, and I think that you would have to do some fairly tight studies to determine totally what the impacts are. Keep in mind that our role is a very conservative one, because as regulatory agencies we have a mandate to protect. Even on the basis of a number of studies that may indicate those situations seem to be of very little problem, it doesn't mean to say that it will always be a very small problem. At the right time and the right place on the Labrador Sea, a spill could mean a fair amount of damage, whereas at a different time and place, it may have a negligible effect. We were talking about the subtle differences, and we can't even begin to address those because, in most cases, we haven't got the equipment, we haven't got the techniques and technology for the enzyme systems that we might want to look at. I'm referring to, for example, fatty acids - instead of looking at species compositions, let's look at fatty acid compositions as a means of detecting subtle changes.

J. Payne:

I refer to studies done in the Gulf of Mexico, where there has been oil input for 25 years, and those in Venezuela. In those cases one can't identify the impacts of oil on the surrounding environment, so clearly it's not a white and black situation.

S. Akenhead:

My reaction to these studies is that they may well conclude that oil is not a significant pollutant in their area, but I'll bet you that almost every premise that conclusion is based on is contradicted by conditions in the North Atlantic. Evaporation of the slick, sea states, there's a lot of strong boundaries in the oceanography of the areas we're considering and a lot of these are concentrated "hot spots". My guess is that we can't accept any of these conclusions from other areas without going through them one by one, and you'll find that you'll have to re-address every premise upon which those conclusions are based. There is such a list of contingencies for an oil spill to do damage and to really be destructive, and so many of the items on that list are met in the North West Atlantic, that you have to be extremely reserved before you take the conclusions that have come from other areas.

D. Karasiuk:

Can we predict any environmental impacts then, without having the actual blowout? That's where your train of thought is leading.

S. Akenhead:

No, it's not. Although I would hope to be one of the last people to say that we would be able to completely predict the effect of a blowout, I do think we can generage scenarios that show that at certain times and under certain conditions, there will be a lot of damage done. We can direct these hypotheses so that they can be addressed. The conceptual models that we built as hypothetical damaging scenarios are testable. If I say that the fish eggs and larvae out there are concentrated along the fronts and that those are also fronts that concentrate oil, therefore the oil has a greater chance of destroying fish eggs off Labrador than anywhere else, then there has to be a hypothesis to go out and look at the situation to see if in fact these conditions could prevail.

H. Squires:

If I may interject after listening to these differences of opinion. This is what you're going to always get when you prepare a document in isolation and you don't present it to a number of referees to read. I would like to address the chairman's first question, how do you prepare such documents? Well you have somebody write them - that's a beginning - but then you have to distribute to people who can referee it. I see quite a mistake by writing a paper on fisheries without then sending it to the DFO to review and give their opinions. I think this is the way to prepare these documents.

D. Karasiuk:

You have a very good point. In document preparation, generally industry uses a one level approach, that is, we go through DINA (Department of Indian and Northern Affairs) or we go through COGLA. They supply their comments and then send their comments back to us, but we have no direct access to the other minds we want to tap such as DOE, DFO and a number of other ones.

D. Hardie:

From COGLA's point of view, that's not true. We would encourage you to go and talk to DOE and DFO, and one of our criticisms is that people do not go and talk to government agencies and get information that is available. Just pick up the phone, call them and they can have it on your desk in no time at all.

L. Coady:

Let's come back again to the problem you (D. Karasiuk) had in preparing these species overviews. The grey literature contains volumes on these species yet when EPS (Environmental Protection Service) and ourselves (Fisheries) and COGLA sat down in January to define research needs, we felt compelled to go to the experts, people like Dick Wells who has been working with cod for thirty years. He can tell you without even going to a textbook about the cod in the Labrador Sea. We're attempting this approach internally as part of a review of perceived research needs. Our department is doing it, DOE is trying it, and COGLA is taking a similar approach. I see textbooks as being of less value than consulting with the experts.

D. Hardie:

I would just like to focus back on the original question that was asked in terms of what is required by a government agency, and in this particular case, COGLA, what are their requirements to make a decision on whether a company should be allowed to drill or whether they should be allowed to go into production. The important thing is to sit down and ask the right questions in terms of what are the perceived impacts of the environment on the operation so that it's a safe operation, and what are the perceived impacts of the operation on the environment.

We all know that we will never be able to understand completely everything we need to know to answer these questions. So it lies with government to decide to what degree are we satisfied with industry's answers to a specific question. Now I don't feel that COGLA should be in the position to make that decision on its own. I think you have to rely on other government service agencies, but I think there's a point where it's the responsibility of government to decide where the cutoff point is in terms of information used, understanding of ecosystems and processes, and understanding of what the potential impact is of the operation on the environment.

As Jerry Payne mentioned before, we have a good understanding to a certain degree of the impact of oil on the environment. Do we have to completely understand the ecosystem in Labrador to make decisions on whether drilling should take place? I don't think we do. I think that there are certain key elements that we have to identify to be able to assess what short-term impacts could be and what long-term impacts could be. It might be the responsibility of industry to participate in the exercise of defining limitations, but I still think it falls basically on government to decide what information is required. Now over the past years the old organization (Resource Management Branch, EMR) has never pro-

vided guidelines to oil companies for the preparation of environmental reports, hence industry has never been in a position to understand what information is required because we have never sat down and decided that. And so there has been a real problem there in terms of government giving guidance to oil companies.

W. Speller:

Well thank you. We certainly have a few differences of opinion and I'm really pleased that you've aired them.

D. Hardie:

We're hoping that will change.

2.3.3 Closing Remarks

W. Speller:

Many of us are getting tired, and I thank you for bearing with me. I'm going to make one point very quickly here that Rolph (Davis) put very succinctly when he said "everybody has a different opinion on what should be in every one of these documents...". Now I would like to ask Bev LeDrew to give some final comments on his views of the session that we've had.

B. LeDrew:

Thank you. Over the last two days I've flitted back and forth and had an opportunity to see how the groups have been functioning.

The general feeling on this document was that it's a dated document. It does need some up-dating, and it does need to have the errata addressed. To a large extent Petro-Canada seems to have been a victim of its own effort. The general thing that came out here was all these recent studies really changed a lot of the sections.

It seems that this document should have either preceded OLABS or waited until after it was completed. There was quite a bit of discussion and effort at explaining it, but generally it seems that the document doesn't seem to have hit the right timing. That's a comment that many people made and perhaps it doesn't need to be repeated.

I think there was also a relatively poor understanding of the objectives and the scope of the document itself as well as its relevance to the approval process. That's probably because it isn't a straight forward document that fits into a clearly defined group or process. That unfortunately did hamper a lot of the discussions.

There appeared to be a problem of authorship and I think a couple of people expressed some frustration at this.

There was general discussion of the relevance of the different sections of the document. I sat in on a discussion of the relevance of the geological section, whether it should have included material on landforms. It's unfortunate but I think the proponent when putting together something like this tends to throw in what should be deleted rather than leave out something that should have been kept in. What you end up with is a very large bulky document. The bulk itself becomes an impediment to the communication, the comprehension of that document. This issue probably goes right back to the comments on the need for guidelines which enable some cutoff decisions to be made.

I was surprised to witness an expression of interest in seeing the Sociological section expanded, not only to include more numbers and figures. You had a group of scientists actually asking for something that gave them a feel for people, a feel for the psychology of the situation. And that's perhaps a sign of where we are with these things. I think that is also connected to a very important issue. This talk about fish and seals and little bugs and such, all comes back to people somewhere along the way.

There was one encouraging comment, that the information generated by these efforts should go into the white literature. There should be every encouragement to industry and also to people in the industry to work towards that. Because of the cost of obtaining this information, it should get the widest possible distribution and it should go through the kind of review process undergone by the white literature.

There was a very strong feeling that because this document is going to get quoted, the criticisms and errata need to be addressed, and to have that response attached to this document or in some way sitting next to it on any library shelf. We all know what can happen to a misquote in the paper. The next day, they come with a retraction. Who ever reads the retraction?

One interesting observation was that there wasn't a lot of distinction between the resource persons and participants. On occasion you couldn't tell the difference and I thought that was very helpful to the discussions.

I saw one thing that I didn't like and I'll share that with you. I saw the case where one participant strongly criticized a section, whereas most other participants had no comment. At the conclusion of discussions, however, the comment was made "well we as a committee then should go along with his criticisms". I thought that, for a group of scientists, this was an irresponsible way to behave. There are

three things you can do: you can agree; you can disagree; or you can say we don't know whether to agree with this or not. It is disconcerting to see a group decide that they would all not only defer to the opinion of one person, but would lend their support to his position.

There was a lot of rationalizing. I saw in one case where the logic went along these lines - we should study the fish larvae but the larvae are there in the winter and we can't work under the ice. Oh well, there won't be a problem with oil then anyhow, so let's not go into that. Right now we have no year round ability to do the kinds of things that need to be done. Even though the operator is now drilling only in the open water season, there has to be a movement towards year-round capabilities. Impacts could be year-round. As well, year-round information is needed in order to understand systems and processes.

That leads me to something that wasn't addressed during this discussion. There is a need for support research to develop research abilities and tools. Industry, resource agencies, and universities need to work towards developing these abilities, for example on enzyme systems, trophic level interactions, and ice structure measurements. It's not good enough to just say - well we don't have a system for measuring that so we won't measure it. There has to be movement in this area of research.

I was glad to see that there were some recommendations for government action because, during a meeting like this, the primary focus tends to be on what industry should do.

In closing, I'd like to thank in particular the chairpersons for being here. I should especially thank Dave Stone who stepped in very, very suddenly. We should also thank Camille Mageau because up until she got ill, she was prepared to take on a chairperson role. I'd also like to take the opportunity to thank all of you participants. I was amazed at your ability to focus on the topic at hand and work through the long hours of meetings. You obviously came well prepared for the seminar and this has contributed to its success.

One final thing I should note is that we have representation here from the Labrador Inuit Association and the Labrador Resources Advisory Council. They will, we understand, be participating in the public review this coming fall. Their participation at this exercise has been essentially as observers as they have not yet had the time which they feel is needed to contribute a detailed review and critisicm of the document. Presumably, this will be forthcoming during the fall meeting.

W. Speller:

Well everyone, thank you very very much for being here. I really appreciate your effort and certainly want to add to what Bev said, especially concerning the chairpersons. I think they did an excellent job.

In many cases, industry has not responded to the comments of these reviews. In organizing this session, Petro-Canada wanted comments and as an industry member, we got your comments. I feel we have a responsibility to respond to the comments and to the efforts that you've put in. We don't plan to entirely rewrite the document, but in responding to your particular comments in terms of an errata and the means of distributing your comments, we will be discussing that with COGLA.

When we organized this program, our idea was to bring scientists together from many different disciplines to communicate. I am very very pleased with this review in that it's not been a situation where specialists tear the hell out of their section, close the document up and go away. We've had a good discussion, about the values of these documents - we've started to talk to each other. I see you people as the representatives of the region who will be commenting in the future dealing with the revolving fund and whatever. If anything, we've all got a better appreciation of where we are in this whole process, what the value of these documents is and where further studies should be going on. Clearly, there are differences of opinion. I think that's very healthy and I'm really pleased about the discussion it engendered.

Lastly I'd really like to thank Bev for the excellent job that he has done in organizing this meeting.

3.0 Government Review Comments on the Offshore Labrador IEA

3.1 REVIEW COMMENTS
DEPARTMENT OF FISHERIES & OCEANS

S.A. Akenhead
Fisheries Ecosystems Section

May 7th, 1982

This is one of the better I.E.A.s I've reviewed in the past three years. It presents a fairly intelligent and very extensive review of the existing literature, pointing out where older literature is inadequate (e.g. net phytoplankton collections). The greatest complaint, beyond our continued ignorance of Labrador, is the lack of comparisons drawn. Occasional mention of inshore-offshore differences are made without considering the two branches of the Labrador Current. North-south gradients are not mentioned except for the adult fish ranges. While T-S properties may be subject to only slight changes through the length of the shelf, I don't expect this to be true for zooplankton or phytoplankton. The lack of comparison to other areas makes it hard to appreciate the data. This stood out for macrophytic algae in my case.

185. There seems to have been a reluctance to discuss the theoretical work on the Labrador Sea and shelf biology, although none of it is secret. Sutcliffe's hyopthesis of nutrient injection from Hudson's Strait and the consequent time-space pattern of aquatic succession of particle sizes down the shelf deserved mention.

185. Comments noted.

186. There is a tremendous amount of work in such a report - I appreciate and value the document. However, it is really just an annotated bibliography (for this section), and, to be rude about it, essentially thoughtless. I can't say that I actually learned much about Labrador biological oceanography. What makes it unique, or fragile, or odd, or interesting. This I.E.A. doesn't say.

186. Comments noted. The kind of speculation and interpretation you're looking for may not be appropriate in a document of this kind. Even the relatively unadventurous interpretations appearing in Section 6.8 were the subject of heated (and ultimately inconclusive) academic debate during the review seminar.

Specific Points

187. 5.7 Chemical Oceanography

- The OLABS transects do not go far enough offshore, and so do not show the shelf-break. Pity. The station

spacing is also too coarse to see any effects of banks, saddles, troughs or fronts very well, although the indications are there in chlorophyll.

187. As discussed earlier, there were very real limitations imposed by time and distance during the OLABS program: the amount and intensity of sampling that can be done during a field season is finite.

188. - There is no dynamic viewpoint here at all - e.g. variable turnover depths of the Labrador Sea might strongly affect the Shelf nutrients; nutrient injection into Hudson Strait was overlooked as a topic (astonishingly); there was little or no attempt to associate water chemistry with water mass origins.

188. These would involve speculations not justified by the existing data base.

189. - USSR workers reported no primary production (DO_2) in April. Does this seem unreasonable? It must mean that ice-off doesn't leave a stratified water column in spite of the fresh water from melting. This simple question should be addressed, and comes back later in connecting epontic algae to spring bloom.

189. See response 188.

190. - MEDS has large files of chemistry data for Labrador, still untilled. This involves extensive USSR chemistry surveys.

190. Petro-Canada hopes that MEDS will soon analyze and publish these data.

191. - 28.9 micrograms/L. of hydrocarbons - what is the significance of this level? (p. 5-145).

191. The intention of this comment is unclear.

5.8 <u>Microbiota</u>

"depletion of nutrients by the spring phytoplankton during the spring bloom reduces the activity of heterotrophic bacteria..."

p. 5-146

192. All those dying phytoplankton are rejected by bacteria? All the DOM primary production is disdained? No, no, no! The author has oddly assumed here that all micro-heterotrophs react to nutrient ions like oleoclastic bacteria utilizing alkanes.

192. It is unclear which statement the critic disagrees with so energetically. However the last two paragraphs in this section accurately reflect the conclusions reached by Bunch (1979).

5.9 Primary Producers

193. - No comparison of macrophyte biomass and productions are made. Is there something unusual about them down there?

193. The intention of this cryptic comment is unclear.

194. - No reference for FAO (1972)

194. Correction noted.

195. - References to Akenhead on p. 5-111 should be to Sutcliffe, Louck, and Drinkwater (1982 in prep.). Leave me out of this, please.

195. Okay.

196. - Regarding Davis Strait phytoplankton: Spring bloom begins with water column stratification, not light increases directly. What good is a sunny day if you get tumbled down to the 1000 m level?

196. Speculation, perhaps.

197. - Holmes ('56) says 87,000 cells/L at OWS-B contrasted to 1,000,000 to 4,000,000 cells/L in Davis Strait. This is obviously an artifact of sampling net phytoplankton versus including microphytoplankton. The text even says this, yet the comparison is tried. Surely better comparisons are possible?

197. This comment misinterprets the text, where no comparison was, in fact, attempted.

198. - The most important observations are the Northern Labrador transect with two distinct phytoplankton assemblages in the inshore and offshore Labrador Currents, corresponding to Steeman-Nielson and Hansen (1961) observations of primary production, and probably to the zooplankton data. Little is made of this, however.

198. This point was discussed in the IEE on pp. 5-154 and 5-155.

199. - The succession of phytoplankton is easily deduced from the presented works and data (pennates - centrics - chrysomonads), but not observed by the authors. This

is very insightful in interpreting upwelling and mixing areas versus stagnant ones.

199. Agreed. However, the sampling design of OLABS work precludes a rigorous statement about seasonal succession.

200. - The primary production section doesn't mention the potential for a great fraction of summer production to be DOM, possibly unmeasured. The fraction missed could be 20-30%.

200. Agreed.

201. - A figure of 24 mg C. m^{-2} for mean summer chlorophyll is given, but without comparisons to establish the area as productive or not. Presumably, the Davis Strait data could be expressed in comparable units at least, rather than m^{-3}.

201. In literature reviews of this kind, we try to avoid comparing apples to oranges.

202. - Page 5-155 says freshwater run-off is high in nutrients. It's not.

202. This comment misinterprets the IEA.

5.10 Zooplankton

203. - I regret the lack of data on seasonality. Don't other areas (northern USSR, Beaufort Sea, Bering Sea) have valuable seasonal studies?

203. Perhaps other areas do have information. However, when the IEA was being written, OLABS studies were unavailable to show how comparable the Labrador zooplankton fauna was to other areas.

204. - Numbers always. What about biomass? Calanus may be outweighed by euphausiids and amphipods.

204. OLABS studies, published after the IEA, do indicate biomass. They confirm the dominance of calanoids in both numbers and biomass.

205. - Reference to Longhurst's presentation of N.W. Atlantic zooplankton patterns seems to be called for here, but is obviously absent.

205. Omission noted.

206. - 4.6 to 16.5 thousand Calanus finmarchicus per m^{-3} is a lot, perhaps 120 to 500 thousand .m^{-2}, which

is 10-40 times my adult Calanus counts for Flemish Cap in spring and summer. Most of these counts must be early copepodites, yet no mention is made of this.

206. **OLABS work was unavailable at time IEA was being written.**

207. - The USSR "Norwestlant" survey data isn't mentioned.

207. **Omission noted.**

5.11 Ichthyoplankton

208. - No mention is made of the pattern of demersal fish replacing pelagics completely in the progression down Labrador. Does it not show in the data?

208. **No. The data are simply too thin.**

209. - 25 to 90 species present detected in the ichthyoplankton. Inadequate or expected?

209. **As discussed in the last paragraph of Section 5.12, the field season for the OLABS studies imposed severe limitations on the interpretations of ichthyoplankton distributions.**

Passing note

210. One section says a "considerable fraction" of a blowout could be oil particles less than 50 micrometers. The next says zooplankton feed on these particles, but risk to them was slight. I'd say the author hadn't looked back at the production of microparticles before this benign conclusion. Food chain accumulation could be quite fast, with recent models concluding trophic level production efficiency of 40 percent (4 x slobodkin). A risk exists here that is not considered.

210. **Bioaccumulation of petroleum hydrocarbons has been the subject of a great deal of speculation, but alas, little empirical study.**

H. Bain
Habitat Management Section

211. By way of a summary statement, I consider the offshore Labrador IEA to be a good, informative document which, for the first time, attempts to consolidate the physical, biological, and socio-economic information pertaining to the coastal Labrador Sea. Petro-Canada has made a commendable effort in producing the IEA.

211. Thank you.

212. As far as a detailed review is concerned, I have no specific comments to make regarding the contents of the IEA. Therefore, no annotated list of specific comments is appended. I do, however, have two general comments to forward. First, the section dealing with environmental impacts, although informative, if not somewhat shallow, is unnecessary in this type of document since its objectives are to evaluate present knowledge and delineate needed research to fill data gaps rather than it being a statement of environmental impacts.

212. This was a point hotly debated during the review seminar. The consensus seemed to be that some analysis of impact was necessary.

213. Second, although I agree with the details of future studies outlined in Section 8.6, I would suggest the addition of detailed shoreline mapping using current information such as that provided by Woodward-Clyde, LGL Ltd., and EPS along with supplemental studies. The aim of such mapping is to improve the predictability of coastal impacts by oil and thus produce more cost-effective contingency plans.

213. Agreed. This work is now in progress in Petro-Canada.

W.D. Bowen
Marine Mammal Section

214. Keith Hay and I have reviewed the marine mammals sections of the Labrador IEA and have the following general comments: The statement on page 1-12 about the publication of data on harp seal numbers is complete and utter nonsense and should be deleted from the report. The general review of section 5 of the report is flawed with a number of minor factual errors, is not particularly up-to-date, and is, therefore, of limited value. I am not impressed with the report insofar as the marine mammals sections are concerned, particularly the parts on whales.

214. A more rigorous critique of the deficiencies of the data on whales would have been welcome.

(See attached)

Comments

215. Page 1-12: I know of no marine mammal that feed on phytoplankton! The second sentence of paragraph two is simply nonsense. Executive summary contains very little useful information.

215. Comment noted.

216. Page 6-68-71: Reasonably good summary of literature on seals. Should have made reference to the American CETAP work in relation to whales.

Page 5-255: Good introduction. I have not had time to adequately review all of the species descriptions, so I will confine specific comments to the section of harp and hooded seals.

216. Specific references would be appreciated.

217. Harp seals: Males mature later than females, not at the same age.
Sargent should read Sergeant.
There is no good evidence that harp seal mature one year earlier at the Front.
Pregnancy rate has varied over time from about 82% to over 94%.
Breeding occurs in water and on ice.
The five-day difference in whelping date is an average and it is closer to a week.

Pups are weaned after 9-12 days not 3 weeks.
Literature on harp seal biology and population dynamics not particularly up to date.
Harp seal rarely feed while molting.
There is no basis for saying harp seal prefer capelin.
What about distribution, migration routes, timing of migration, numbers, trends in abundance? None of these topics are covered.

Hooded seals: We don't know that each of these breeding areas is a distinct population. It is likely that there is significant interchange.
Again males mature later than females.
Weaning is probably 5 to 7 days.
We don't know what the mating system is - monogamy, serial monogamy, promiscuous?
Females desert pups after weaning, mating occurs subsequently.
No detailed discussion of location of breeding patches in relation to possible vessel traffic.
What about number, trends in abundance?
I suspect that other descriptions are equally plagued with errors and omissions. Surely we should demand a more accurate and detailed review.

217. **Corrections noted. We would have appreciated a more rigorous commentary on <u>all</u> species, in view of the somewhat damnatory dismissal of this section in your covering letter.**

J.E. Carscadden
Pelagic Section

Comments on capelin

Page 5-228

2nd Paragraph

218. "The offshore Labrador fishery was conducted mainly by USSR vessels. Canadian and Norwegian vessels were there only on an exploratory basis. The only purse seining was conducted on an exploratory basis".

218. Correction accepted.

4th Paragraph

219. "The first estimates of capelin biomass were calculated by estimating predator stocks and their consumption rates of capelin; subsequent analyses have used different methods".

219. Correction accepted.

220. The latter point illustrates my general comment that this manuscript is not up-to-date. The most recent references listed seem to be 1978 (an occasional 1979). This may be due to the time required to compile and publish this information but in capelin which is fairly dynamic, the lack of up-to-date information is telling.

220. This section was baded on Sandeman and Buchanan's (1980) OLABS review of the Labrador fishery; preparation of the IEA began in January 1981.

221. Surely the authors could have found a more factual reference than Akenhead 1977 - unpub. data to that up to 80% of the diet of cod is capelin. Knowing the variability of cod feeding I would be very suspicious of one figure for all years and especially one that comes from unpublished data. Serious misgivings about this.

In spite of being slightly dated, the coverage of capelin is pretty good.

221. The variability of the cod's diet is discussed in considerable detail on pp. 5-188 to 5-185 of the IEA.

222. With reference to herring and mackerel the document states that virtually nothing is known of stocks in the Labrador area. This is unfortunately true!

222. Agreed.

Larry Coady
Scientific Program Co-ordinator

223. Petrocan's IEA succeeds in clarifying the majority of concerns raised by offshore exploration in the Labrador Sea and serves as an excellent "springboard" to future research and assessment planning in the area. The singular initiative shown by PEX in preparing the document and providing for the scientific and public review of its contents reflects a responsible stance to development and a welcome commitment to ongoing industry/government/community interaction.

I did note several significant shortcomings and many minor inconsistencies in the document. The former are outlined below. Specific comments in different subject areas have been well treated by other reviewers and are not repeated.

Comment #5 (perceived research needs) is offered for workshop discussion purposes.

223. Thank you.

1. Executive Summary

224. For those interested in an "abstract", the executive summary serves to re-state important features of the text. This it does! The facts are there, extracted where appropriate from the report. To anyone unfamiliar with the study area, it must further synthesize these facts to ensure recognition that "Labrador is like nowhere else in the northern hemisphere". For the decaffinated reader faced with 548 pages of science and technology, the executive summary must also "perk" sufficient interest to motivate a marathon reading session. Judging from the many fine features of the IEA, this shouldn't have posed a problem. Labrador is different, a unique blend of physical, ecological and social criteria which sets it apart from Davis Strait to the north and Newfoundland to the south. It is an area of subarctic transition, a southward extension of the Arctic condition, physically dynamic, ecologically sensitive, poorly studied and stretching the limits of offshore drilling technology. The facts are there, the message, however, isn't.

224. A number of fisheries-related items in the executive summary require clarification.

- 1.2 Environmental Studies in the Labrador Sea

fisheries enchancement (?) should perhaps have read fisheries assessment

- 1.5.13 Marine and Anadromous Fish

Cod spawning on the Hamilton Banks, the southward drift of larvae and the tremendous importance of the 2J3KL stock complex constitutes a principal sensitivity and warrants greater profiling.

Anadromous Arctic char extend south to Newfoundland. Atlantic cod are found northward in Iceland/Greenland. Stated ranges are incorrect in both cases.

Other anadromous species found in Labrador include brook trout, smelt, and American shad (rare).

Eels spawn in the tropical North Atlantic south of Newfoundland/Labrador.

The sudden transition, just north of Hopedale, between Atlantic salmon and Arctic char utilization of freshwater watersheds is an important feature of Labrador salmonid ecology.

224. - 1.5.16 Marine Mammals

The controversy surrounding the Nfld. seal hunt has enhanced rather than hindered development of the data base. Page 5-260 (3rd paragraph) is consistent with this correction.

While the ringed seal is the most common and widespread resident seal, the harp (est. two million 1+ animals) migrates through or occupies the area for more than half the year. Whelping patches of harp seals on the ice floes at the Front (southern Labrador - northeast Nfld.) constitute the most important feature of marine mammal ecology in the area. While clearly referenced in the text (p. 5-260, 6-69, 6-71) the executive summary brings little focus to the matter.

224. The executive summary has subsequently been rewritten to encompass these comments.

225. 2. Fishing industry conflicts

Oil and fishing industry interactions are of considerable concern yet have not been addressed in any detail in the IEA. The North Sea experience forebodes poor relations and the local fishing industry has expressed clear doubts for the future (debris, loss of access, manpower shortfalls, pollution, compensation, liability, etc. etc. etc.). Attitudes are important; effective liaison essential; sound regulations critical.

225. Agreed. Had it been available at the time the IEA was being prepared, NORDCO's (1982) analysis of oil industry/fishery interactions in Newfoundland would have been a primary source.

3. Contingency planning and countermeasures

226. Preliminary (1981) outlines of the IEA featured sections on oil spill contingency planning and countermeasures. Lancaster Sound and EAMES panels paid considerable attention to these sections in previous EIS hearings and subsequent summary reports. Why has it been found unnecessary to duplicate contingency material in the present IEA. Perhaps the matter is worth discussing during the Workshop? Many salient features of drilling operations (eg. iceberg towing, ice alert and cutoff zones, rig inspections, logistics support, etc.) and countermeasures strategies and impacts (eg. dispersant use and cold water effectiveness, physical containment and clean-up, oil detection and tracking, waste oil disposal, shoreline restoration) would add to the value of the document especially for those who were never involved in contingency planning reviews.

226. It was decided that it would have been pointless to discuss contingency planning in the IEA, because an accepted contingency plan was already available to the interested reader.

4. Other topics

227. The proponent should consider the inclusion/improvement of the following additional material in the IEA:

a) seismic operations in advance of exploratory drilling; explosive vs. non-explosive energy sources; approval mechanisms

b) general chemistry of oil and weathering processes; a diagram illustrating chemical and biochemical degradation (spreading, drift, evaporation, dissolution, emulsification, sedimentation, etc.) against time would be useful

c) fate of rig washings (cf. drilling wastes)

d) mud disposal practices when hydrocarbons are encountered; permissable levels of oil release; exploratory vs delineation drilling

e) environmental comparisons with Davis Strait and the Grand Banks; weather, ice and other criteria

f) evaluation of shore-based sites; environmental risk indices

g) seasonal influence of river discharges on inshore oceanography (aside from freshwater influences associated with Hudson/Baffin)

h) extended season provisions/allowance for relief well drilling relative to ice conditions

i) oceanographic and biological features of the Strait of Belle Isle

j) public relations and public involvement in future studies

k) consideration of possible development-free areas; criteria

l) applicability of BIOS studies to Labrador situation

m) remote sensing opportunities (baseline studies, oil detection)

227. Suggestions noted. Space and time do not permit evaluation of the need for relevance of these topics in a preliminary assessment such as the IEA.

5. <u>Perceived research needs</u>

228. The following checklist of fisheries-related research gaps in the Labrador Sea has been identified in conjunction with research staff in the Nfld. Region. Physical oceanographic priorities will need to be developed with OSS. Similar exercises have been completed for Newfoundland. Full details on each proposal have been developed. DFO, DOE and COGLA agreed to the joint provision of

"perceived research needs" documentation during meetings in January.

- cod spawning and larval dispersal, 2GH and 2J3KL
- ocean fronts, shelf break and ice edge processes
- ocean climate indices
- marine mammal distribution and ecology
- seabird/fisheries interactions
- biological oceanography/seasonal variability
- MFO induction and potential for delineation of point sources of oil contamination in the benthic marine environment and fish larval habitat
- nearshore studies (biophysical categorization of shorelines, sublittoral communities, estuarine features, salmonids)
- offshore benthic communities and baseline sediment monitoring (chemical constituents)
- computerized commercial fishing activity mapping
- forage species (capelin, Arctic cod, Arctic squid, sand launce); relationship with major commercial species
- tar ball degradation rates
- correlation of hydrocarbon contamination with fish tainting
- dispersion of drilling mud under different current regimes
- Labrador fiord sensitivity to oil
- impact of heavily contaminated intertidal sediments on sublittoral algal communities
- hydrocarbon bioavailability from sediments contaminated with low levels of petroleum
- impact of larval mortality on fish populations and fisheries recruitment
- establish dose-response (sub-lethal) relationship for selected commercial fish species

- develop indices for assessing sub-lethal effects in invertebrates
- possible use of algae as monitoring species
- distribution, abundance, breeding biology and feeding patterns of ringed seals, harbour seals and grey seals
- inshore/offshore distribution of harp seals during migration, relationship to ice
- further work on harp seal feeding in far northern Labrador
- distribution, areas of concentration and timing of migrations of more abundant cetacea
- offshore distribution of salmonid post smolts and overwintering areas
- beach spawning locations of capelin
- diel changes in speed and direction of currents in the Labrador Channels
- food and feeding in offshore cod and turbot.

228. **Perceived research needs have been noted. A list such as this is a welcome indication of the kinds of studies DFO would like to see done. Section 8 of the IEA has presented industry priorities. In doing these studies, the allocation of costs, expertise and manpower among government and industry will be a subject of continuing negotiation.**

B. Dempson - Freshwater and Anadromous Fisheries Management Program

The main objective of Petro-Canada's offshore Labrador initial environmental assessment was to provide a comprehensive review of baseline biological and environmental information on the coastal and offshore Labrador area that could assist later in the environmental assessment of hydrocarbon development in the region.

229. A vast amount of information appears to have been consulted regarding the physical, chemical and biological environment of the region. A number of new valuable biological studies were conducted particularly those dealing with marine mammals, seabird populations and nearshore studies of benthic invertebrate communities. With respect to anadromous and catadromous fishes, no

specific biological investigations were carried out. All information included on these fishes was derived from existing literature.

229. True.

230. A general feeling for the report was that given all this physical, chemical and biological information, there is still considerable speculation concerning the possible effects of oil on biological systems. In fact it was stated that very little is known concerning the movement of oil in marine food webs. Information on the distribution, abundance and biology of organisms in the study region is undoubtedly very important. However, my feeling at this stage is that given the amount of natural variation and fluctuation in biological systems, often only indirect inferences can be drawn regarding short- and long-term effects of a blowout in the Labrador area.

230. Agreed.

5.13.3 Anadromous and Catadromous Fish

231. Sections dealing with life history summaries for anadromous and catadromous fish are relatively complete, although short, for Atlantic salmon and Arctic char. Very little attention, however, is directed towards the biology and life history of trout, smelt, and American eel. It is recognized that the paucity of information on the latter three species is likely related to the availability of biological information on these species in the Labrador region and their relative importance as commercial species. No mention was made of American shad which has been reported.

231. Agreed.

5.14.4 Major Species of the Labrador Fishery

232. With respect to commercial fisheries, adequate summaries are provided from the existing literature for the Atlantic salmon and Arctic char resource. Background and development of both fisheries are briefly covered. Some of the information, however, is now outdated and recent developments, for example in the northern char fishery since 1979, are not covered.

232. Agreed. See response 220.

233. Factors responsible for controlling stock sizes of salmon are presented in this section. These factors, of which many are equally applicable to Arctic char, are given very little discussion. In terms of freshwater

and anadromous programs, these factors are of considerable importance to the resource and possibly warrant a discusion more elaborate than that which is currently presented.

233. **Although many of these factors are important in managing anadromous fish, they may not be particularly relevant to assessing the effects of an offshore oil spill.**

8.4 - 8.7 Future Offshore Labrador Studies

234. The OLABS program was primarily biologically oriented with numerous studies concentrating on species and communities most threatened by oil pollution. Much of this emphasis was placed on studies of marine bird colonies, marine mammals, and intertidal biota. Future studies appear geared toward increasing the physical, chemical and sea-ice information and meteorological conditions prevailing within the region. Studies "will be planned and conducted with the criteria of predictiveness and efficiency in mind". It is interesting to note the emphasis on a computer oriented approach for predictiveness in light of Johnson's (Assessment of the effects of oil on Arctic fisheries, 1982) comment that predictability is generally of a low order and is largely restricted to an assessment of probabilities. Undoubtedly studies should coordinate and integrate physical, chemical, environmental etc. information with biological data in order to obtain, as Johnson pointed out, a better understanding of the dynamics of ecosystem functioning.

234. **Agreed.**

235. Nearshore areas often are the most productive and most seriously affected by oil contamination. Given the high economic importance of the inshore fishery to coastal communities, additional studies could perhaps be designed to investigate more thoroughly the effects (direct and indirect) of oil contamination on the important commercial fish species. As summarized in Table 5.25 for 1979, approximately 50% of the income from the inshore fishery is derived from anadromous species (trout, char, salmon) for the area Indian Isle to Cape Chidley (Statistical Sections 52 and 53). For the region extending from Cape Harrison to Cape Chidley (Section 53) this figure increases to approximately 75%.

235. **Study recommendations noted. However, these studies have a relatively low priority for industry at present.**

236. Oil in nearshore areas may interfere with the ability of char and salmon to return to their spawning rivers

(Section 6.8) although this has not as yet been demonstrated. Effects of oil on dominant food items is important but difficult to predict.

236. Agreed.

237. Virtually nothing is known on the fate of salmon smolts after leaving immediate estuaries and bays adjacent to their home rivers. Distribution and abundance of salmon smolts in coastal and offshore areas and how oil pollution could enhance or alter factors affecting their survival are speculative.

237. Agreed.

W.H. Lear
Groundfish Program

Generally the IEA is a well written and exhaustive document. There are some gaps in the groundfish section which I have detailed in my review comments.

238. Generally the effects of oil on homing ability and migration of highly migratory species such as salmon and cod are treated very superficially perhaps because so little work has been done on the effects of hydrocarbons on the chemosensors of these species. This might be critical for cod if as we suppose they migrate pelagically near the surface where they are liable to oil contamination.

238. Agreed. The literature is deficient in this regard.

(see attached)

Offshore Labrador Initial Environmental Assessment

Page	Para.	Line	Comments
239. 1-11	1	4	Actually the peak of the offshore cod fishery occurred in the late 1960's.
1-11	2	2-3	The northern (2J3KL) cod quota in recent years (1980-1981) has been allocated mainly (95%) to Canadian fishermen.
5-182	2	-	There is no reference to the fecundity of Atlantic cod off Labrador, the variations in fecundity and the factors affecting this variation. Also there is no reference to age (size) at first maturity, the varition of this age in relation to stock size and other biological density-dependent and/or on environmental parameters such as food supply, growth rate and temperature.
5-186	2	3-4	Actually S. fasciatus has already been distinguished and described by I. Ni.
5-190	4	5-6	The Greenland halibut of the Gulf of St. Lawrence have vertebral averages significantly different from those of other areas. The presence of mature Greenland halibut and spent females indicate a small spawning stock within the Gulf.
5-192	1	5-7	Templeman (1966) found that in southern Labrador the largest catches of witch flounder (5000 and 3000 lb per hour) were in depths of 549 and 640 m respectively during April 1963 at the mouth of Hawke Channel. Also during 1964 in this area the witch were largely concentrated at about 550 m; these were presumed to be prespawning concentrations.
5-195	5	6-9	The distribution of Arctic cod off Labrador and Newfoundland has been described in a CAFSAC Res. Doc. 79/7.
5-195	5	10-12	A CAFSAC RES. Doc. of 1979 makes an estimate of about 100,000 t of young-of-the- year Arctic cod of

southern Labrador and northern Newfoundland.

239. Comments and corrections are accepted. This additional information would have been welcome in the IEA. The comments point to the value of having draft environmental documents vetted by experts before such documents are printed in final form.

240. 5-208	2	8-11	May (1967) attributes the decreased catch/effort of the Labrador inshore fishery to the increased effort offshore from trawlers who in 1969 landed 800,000 MT of cod from the 2J3KL cod stock far in excess of the maximum sustained yield of 550,000 t (Pinhorn, 1967).
5-208	2	-	For a more detailed account of the effects of the environment on the inshore fishery, see Templeman (1966).
6-2	1	-	Is there any section that deals with the effects of oil on fishermens nets and which would directly affect their livelihood through reduced catches from fouled nets or having to remove nets from the water during the peak of the fishing season?

240. Unfortunately, no. See also response 225.

D.G. Parsons
Shellfish Section

241. Although I have not read the complete report, the data contained appears to be extensive and informative. Obviously, considerable effort has gone into its preparation and it is imperative that the information is presented succinctly and accurately. However, in reviewing the brief sections on invertebrates, I find some errors and misrepresentation. If other sections are of similar quality, some revision would be in order before the final report is released.

Extremely interesting is the direction of future research in relation to physical and chemical oceanology. I am particularly interested in deployment of current meters in and near areas of shrimp concentrations and surface circulation studies have broader application. Sediment analysis is another area of interest. It would be advisable to be kept informed on developments along these lines in future, so we can supplement our fragmentary or non-existant data base and aid the oil industry with our own findings.

(see attached)

241. Comments accepted.

Comments on IEA Review - Invertebrates

242. Page 5-170, Section 5.11.5, Paragraph 3, Line 9:

'...until hatching occurs, usually in spring.'

Page 5-170, Section 5.11.5, Paragraph 3, Lines 10, 11 and 12:

'...larvae pass through several pelagic larval stages and after a few months settle as juveniles in shallow water, relative to depths where adults are found.'

Page 5-171, Paragraph 2, Line 3:

Delete sentence beginning with 'At present'.

Page 5-171, Paragraph 2, Line 4:

'In the Newfoundland-Labrador area, shrimp...'

Page 5-171, Paragraph 3, Line 1:

Delete 'most'.

Page 5-171, Paragraph 3, Line 4:

'Off Labrador, shrimp concentrations have been reported in depths...(Brothers, 1976a, 1977)'.

Page 5-171, Paragraph 3, Line 6:

'They are generally fished commercially in depths greater than 300 m...'

Page 5-171, Paragraph 3, Line 7:

At this and numerous locations reference is made to 'Parsons *et al*. 1974'. This should be '1979' in all instances.

Page 5-171, Paragraph 4, Line 2:

Delete '...occurring the whole water column throughout the night...'

Page 5-171, Paragraph 4, Lines 4 and 5:

'...in the deeper water, while...'

Page 5-171, Paragraph 5, Line 1:

'...trawling off Labrador only...'

Page 5-171, Paragraph 5, Line 3:

'Commercial concentrations of shrimp...'

Page 5-171, Paragraph 4, Line 4:

Delete 'and channels'.

Page 5-171, Paragraph 4, Line 5:

'...Hawke, Cartwright, and Hopedale Channels'.

Page 5-171, Paragraph 4, Line 6:

'Hopedale Channel' not 'saddle'.

Page 5-171, Paragraph 5, Line 10:

'...on the seaward slopes of the channels where...'

Page 5-172, Paragraph 1, Line 1:

'Concentrations of Labrador shrimp in the channels have not been shown to constitute separate stocks?

<u>Page 5-172, Paragraph 1, Line 3</u>:

'...limited intermingling of shrimp between...'

<u>Page 5-172, Paragraph 1, Line 5</u>:

'Specific areas for spawning are not known...'

<u>Page 5-172, Paragraph 1, Line 7</u>:

'Labrador shrimp stocks may be sustained by spawning populations within the channels. Some larval drift from north to south may also be possible but it is not known whether or not the offshore stock in the Davis Strait contributes to the Labrador areas.'

<u>Page 5-172, Paragraph 1, Lines 9 and 10</u>:

'...was approximately 2600 and 3600 tonnes respectively.'

<u>Page 5-172, Paragraph 1, Lines 10, 11 and 12</u>:

'A potentially substainable yield has been estimated to be around 6000 tonnes annually. These are based on crude estimates of biomass obtained from research surveys'.

<u>Page 5-172, Paragraph 1, Lines 21 and 22</u>:

'...these species are not caught in sufficient quantities to be of value to the industry.'

<u>Page 5-172, Paragraph 2, Title, Line 8</u>:

'...utilize crab traps...'

<u>Page 5-172, Paragraph 2, Line 9</u>:

Delete 'however, many crabs...etc.' There is now a regulation prohibiting this.

<u>Page 5-172, Paragraph 3, Line 2</u>:

Include 'Watson (1975).'

<u>Page 5-172, Paragraph 2, Line 6</u>:

'...are planktonic for several months...' Then delete the sentence starting with 'At 55 mm...' since it only applies to the Gulf of St. Lawrence.

Page 5-172, Paragraph 3, Line 8:

Change this sentence to: 'After attaining sexual maturity males continue to grow while growth in females ceases.'

Page 5-172, Paragraph 3, Line 9:

This should be two sentences. Try 'In order to grow, crabs must shed the hard exoskeleton through moulting. This process removes all chitinous material which might otherwise reflect growth, making the ageing of catches (and other crustacea) difficult.'

Page 5-172, Paragraph 3, Line 11:

'...with carapace widths 95 mm and greater (Miller, 1976).'

Page 5-173, Paragraph 1, Title, Line 3:
(*Chlamys islandica*)

Delete 'as far south as...etc.' and replace with 'fishable concentrations occurring as far south as St. Pierre Bank (Naidu *et al*. 1982). This reference is: Naidu, K.S., F.M. Cahill, and D.B. Lewis. 1982. Status and assessment of the Iceland Scallop, *Chlamys islandica*, in the northeastern Gulf of St. Lawrence. CAFSAC Res. Doc. 82/12, 79 p.

Page 5-173, Paragraph 2, Lines 1-3:

Delete these two sentences and insert 'A substantial fishery for the Iceland scallop occurs in the northeastern Gulf of St. Lawrence. Growth and survival characteristics of scallops in this area have been examined in detail (Naidu *et al*. 1982). Recruitment into this area may well depend on larval drift from populations spawning along the Labrador Shelf (Naidu, pers. comm.).

Page 5-173, Paragraph 3, Lines 4 and 5:

'It is less common in Labrador then in the Newfoundland area, etc.'

Page 5-173, Paragraph 3, Line 7:

Delete 'great'.

Page 5-173, Paragraph 3, Lines 14 and 15:

'Recently, a small offshore trawling fishery has developed on the Grand Bank but the major offshore fishery is prosecuted on the Scotian Shelf. The squid ...etc.'

Section 5.14.4:

Although shrimp is mentioned previously as an important offshore species, it is not included in this section. Based on the $$$ involved, it should be.

Page 5-317:

References. Parsons, Veitch and Legge should be on the preceding page and Parsons, J.L. *et al*. should be deleted because it already appears on the preceding page.

242. Comments and corrections are accepted. See also response 239.

J.H. Payne
Habitat Research Section

243. General: The IEA is commendable since it attempts to deal with the large amount of literature available and to present a balanced perspective on the possible environmental effects of offshore oil development. The evaluation of the degree of impact that might be sustained by different animal groups seems to be quite reasonable and the overall tenor of the Report is not unlike that found in other recently published perspectives.

243. Thank you.

244. In further studies (here and elsewhere) one should be cautious about the benefits of expensive ad hoc biological surveys, beyond their general intent which is to provide information of a very qualitative nature on the general distribution of various species. Probably in the future more attention should be placed on hypothesis development and evaluation before action is initiated. For instance many "older" hypotheses on oil spill fate and effects can, on the basis of the scientific evidence available, be rejected.

(see attached)

244. Agreed. Baseline studies permit only limited interpretations. Unfortunately, process-oriented studies can be costly and take years to complete.

Specific Comments

245. 1. Comment: (Page 1-14)

"Hydrocarbon concentrations in seawater beneath oil slicks are usually lower than concentrations that are toxic to marine biota".

Response: Generally true, but one can expect exceptions.

2. Comment: (Page 1-15)

"There is little information on the movement of oil in marine food webs generally...".

Response: Agreed, but there is a substantial amount of circumstantial information indicating that oil is not "retained" in food webs.

3. Comment: (Page 1-18)

"Future environmental studies off Labrador will probably be multi-disciplinary and rigorously goal-directed".

Response: This is a sound approach.

4. Comment: (Page 5-147)

"Bunch concludes that oil from a blowout that occurs in late summer or fall would be subject to reduced levels of biodegradation because of low nutrient levels".

Response: Not necessarily, oil will generally disperse over a large area reducing nutrient "demand".

5. Comment: (Page 6-2)

"There have been few laboratory and field experiments to explain the effects of oil on Arctic and sub-Arctic organisms".

Response: Not really correct, there have been a large variety (likely several million dollars worth) of studies carried out in Alaska, the Beaufort Sea, Greenland, Canada, Norway and the USSR.

6. Comment: (Page 6-2)

"Fishes, zooplankton, and phytoplankton would be affected by the more soluble, light fractions of oil (up to C-14) for an oil spill".

Response: Generally true for acute toxicities but compounds of higher molecular weight are probably of more importance in chronic toxicity e.g. heavily contaminated sediments.

7. Comment: re drilling muds (Page 6-9)

Response: Seems to be a reasonable assessment but (as indicated in research recommendations) selected modelling studies would be helpful.

8. Comment: re weathering of oil (Page 6-27; 6-33 and 6-36)

Response: The rates and effectiveness of various processes are probably a little too definitive, given the limited data base for cold waters.

9. Comment: (Page 6-38)

"Alterations in air quality as a result of a hydrocarbon spill are unlikely".

Response: Generally true unless a large spill moves into a populated area. Should also consider air quality around any major bird colonies during egg incubation.

10. Comment: (Page 6-40)

"In such an environment oil may persist for decades.

Response: Probably only in the upper reaches of intertidal zones. The "oil persists for decades" statement is often popularly misrepresented.

11. Comment: (Page 6-64) re oil and fish chemoreception.

Response: These hypotheses can't be disproved but they seem not to have found support in various types of field and laboratory studies.

12. Comment: (Page 6-67) re the LeDrew Gustajtis Scenario

Response: The magnitude of the impacts noted in the model should be highly improbable.

13. Comment: (Page 6-76). "The impact of oil on echinoderms such as sea-stars, brittle stars, sea urchins or sea cucumbers cannot be predicted at present".

Response: These species appear to be quite resistant to the acute effects of oil, but information is needed on sub-lethal responses for the purposes of environmental monitoring. Such information is important because most of these species are dominant members of offshore as well as inshore benthic communities.

245. **Petro-Canada agrees with the comments and qualifications made in points 11-13.**

246. 14. Comment: (Page 8-24)

"In particular, the petroleum industry hopes that the commercial fisheries sector and the hydrocarbon shipping sector will do more to collect environmental data in future, because the industry could create environmental disturbances at least as great as those of the oil industry..."

Response: I agree that these industries have in the real sense the potential to cause certain types of environmental impact just as great as those of the oil industry. I also agree in principle that they should not be immune from the rules and regulations required of others. I do anticipate however that the subject, especially in relation to the fishing industry, would be a political and ideological hornet's nest. On the "scientific side", I also have reservations about the organizational problems that would be involved in collecting reliable data. There may indeed be areas however where they could participate and the topic should be discussed more fully.

246. It's true that asking the fishing industry to shoulder part of the burden of offshore environmental studies would entail political difficulties. However, the fishing and marine transportation industries are potential users of the data that the petroleum industry collects. Further, both those industries have a greater potential for changing the offshore environment irreparably through overfishing, through the thoughtless disposal of domestic waste, bilge, offal and garbage, and through accidental spills of fuels and other chemicals. In effect, this comment suggests a double standard. The petroleum industry is asked to operate under rigorous controls and to perform costly justifications for events that have an extremely remote risk of ever occurring. By contrast, the fishing and marine transportation industries are rarely asked to justify actions that almost certainly have profound chronic effects on the environment. Contrast, for example, the hundreds of murres that drown in gillnets every year to the number that have been killed by blowouts from offshore wells.

R.J. Wiseman
Program Head
Experimental Ecology

Review of Petro-Canada's I.E.A.

General Comments

247. This document is not a definitive statement on potential impact upon the marine and social environment as a consequence of offshore oil and gas-related activity. This is not to be considered a fault or deficiency; I really don't think the authors attempted to produce a definitive document on impact prediction. What the document does do fairly well, however, is examine our state of knowledge respecting the Labrador inshore and offshore marine environment and social circumstance and make generalized statements about possible impact. More importantly, I feel, the document examines knowledge gaps, deficiencies, etc. that are germane to our ability to make finite, quantifiable impact prediction at some further point down the road. This really is the most important feature of the whole exercise, to my mind. I was somewhat disappointed in the fairly general, bland treatment of research needs towards the end of the document. I had hoped for something more substantial; something more detailed as to the specific research needs perceived by Petro-Canada. Perhaps I was naive in this regard. I can now only hope that the intent is to have these research priorities identified in detail during the course of the forthcoming workshop in St. John's.

Overall, the document is rather good; a much better job than most oil industry documents we've reviewed during the past year or so. It is far from perfect and glaring, annoying errors are evident throughout. The substance, however, is relatively accurate and pertinent.

247. Regarding the "general, bland treatment of research needs". A specific detailed treatment would have committed Petro-Canada to a research program that it may not be able to modify later due to funding restraints or altered priorities. Petro-Canada tries not to make promises that it cannot keep.

248. I am a bit concerned by the somewhat artificial and short-sighted boundaries, imposed by Petro-Canada, surrounding all immediate research to be undertaken in the Labrador Group's area of interest. The focus is restricted almost entirely to exploratory drilling concerns. The recognition that production is quite a few years down the road notwithstanding, I do feel more consideration has to be given to the production phase in terms of research needs. While it is indeed prudent to approach the whole process in a step-wise fashion, I also do not believe you can afford to wait for a major oil discovery before addressing impact areas related to oil production. The stated intentions regarding a cod eggs and larval study is a case in point.

248. It is true that the document is concerned with exploration, not production. It is still not known whether there are commercially viable hydrocarbon fields anywhere in Labrador, nor where such fields might be. To address production now would require the services of a professional prophet.

249. More specific points I'd raise at this time relate to Petro-Canada's philosophy and objectives for future research. First of all, I strongly support the operator's initiative in undertaking a broad, regional study of the physical environment. I do feel, however, that similar efforts in biology are necessary and that these should be undertaken hand-in-hand with the physical studies.

249. Petro-Canada supports the first point.

250. Secondly, I strongly feel one of the overriding priorities for future studies should be that they directly support the need to make quantitative impact prediction. It seems Petro-Canada is "putting the cart before the horse" by not including this as a priority and at the same time including mitigation and environmental protection as a priority. After all, you have to be able to predict and measure impact before you either prevent or mitigate impact.

250. Petro-Canada cannot support the second point. This argument is like saying that a firefighter cannot put out a forest fire unless he knows the species diversity, trophic interactions, degree of insect infestation, and faunistic composition of the forest. Although these data might be useful to know for other reasons, they have little applicability to putting out a real forest fire. The same arguments apply to contingency planning and mitigative techniques in the offshore.

251. Thirdly, I found a deep philosophical, and yet pragmatic, problem with Petro-Canada's idea that government should be doing more in the collection of baseline data to assess impacts from developments. Further, the operator suggests the fishing industry should be shouldering some of this load. I cannot support this. Government's role, and particularly DFO's, is to do the research necessary for an understanding of biology and the environment as it pertains to the effective management of resources. If we are to follow after every developer or development proposal and do research supporting impact prediction, we would be doing nothing else. This Department stopped doing that in the '60's! If, however, during the course of our management-oriented research we develop information and data which assist in impact prediction by industry, so much the better! Similarly, if industry produces data with resource management implications during the course of their impact prediction-oriented studies, so much the better!

251. **The third point misinterprets the intentions stated in the IEA. Industry's intentions are to support environmental research that is goal-directed, and that has immediate, direct application to engineering design, improved mitigation, and improved monitoring of environmental change. Industry now gives low priority to research that generates data which might be "nice to know", but which would not alter engineering designs, operating procedures, or response to environmental emergencies in any case.**

See also response 246.

Review of Petro-Canada's Labrador IEA

Specific Comments

1.0 EXECUTIVE SUMMARY

252. 1.5.13 Marine and Anadromous Fish p. 1010, para. 2

- The Labrador coast is not the southern limit of the range of arctic cod and arctic char! The coast of Newfoundland is though!

para. 7

- The American eel spawns in the Sargasso Sea more specifically, technically, part of the North Atlantic.

1.5.16 Marine Mammals p.1-22, para. 2

- The controversy surrounding the Seal hunt has not hindered the publication of data on harp seal numbers and population dynamics; if anything, it has provided an impetus to get this information into the public domain!

1.6 ENVIRONMENTAL IMPACTS AND MITIGATIVE MEASURES

1.6.2 Effects of Baseline Drilling Operations
p.1-13, para. 2

- Re. Petro-Canada ensuring that drilling fluids are relatively free of heavy metal contamination: Can Petro-Canada indicate source of its barite? Is it from Buchans mine tailings?

1.6.6 Effects ... of Offshore Labrador
p. 1-14, para. 5

- Statement suggesting hydrocarbon concentrations beneath a surface oil slick in seawater are not toxic is incorrect and misleading. Concentrations in the immediate column often are in low ppm range which is acutely toxic to larval fish and some invertebrate larvae. As well, ppb concentrations usually experienced are demonstrated to be sublethally toxic to marine biota.

1.6.7 Effects of Oil on the Biological Environment
p. 1-15, para. 3

- Surface oil slicks would also affect eggs and larvae of selected fish species which float at the surface in addition to "floating" in the upper water column.

- "Benthic organisms" should be expanded to indicate invertebrates as well as some benthic finfish such as flounders.

- Herring lay their eggs on the bottom where they attach and would be vulnerable to oil in sediments.

252. **The executive summary has been rewritten to encompass these comments.**

5.0 PHYSICAL AND BIOLOGICAL ENVIRONMENT

253. 5.9.3 Epontic Community p. 5-155, para. 6

- I consider lack of knowledge on the Labrador Sea ice biota an important data gap needing filling. Documen-

tation of this community, the contribution made to overall primary production by epontic algae, and the risk created by under-ice oil for this production should be established.

- There would appear to be something missing between the last line of this paragraph and the first line of the rest of the paragraph on page 5-156.

253. Information on the epontic community may be useful to know for other reasons, but unfortunately has little direct application to spill response at present. The only proven techniques for cleanup of oiled ice is to wait for oil to migrate upward through brine channels in the spring, then to burn the oil in situ when it forms puddles on the ice surface. By that time, the damage to the epontic community may already have been done.

254. 5.10.3 Distribution and Abundance p.5-160, para. 4 and Figure 5.52

- What is shown here is biomass or abundance, not productivity or production! Abundance cannot be used to describe production.

254. Correction noted.

5.10.4 Seasonal Patterns and Productivity p.5-162, para. 2

255. - Because zooplankton became progressively less important in the diet of higher biota in more northerly environments (one of which is the Labrador Shelf/ Coast) giving way to zoobenthos, I feel lack of know- ledge of the distribution and production of deeper water zoobenthos is a research area requiring more effort. Further elaboration of this concern is expressed further along in this review.

255. The need for more information on deepwater benthos is frequently stated in Dr. Wiseman's comments. Most researchers would agree that benthic organisms in shallow waters are vulnerable to surface oil slicks, but that the concentration of dissolved hydrocarbons beneath slicks decreases rapidly with depth in the water column. Dr. Wiseman apparently believes that deepwater benthic organisms are as much at risk as benthos living in shallow water. So far as field evidence is concerned, the literature appears to be silent; this has not impeded specultation, however.

5.11 BENTHOS

5.11.1 Introduction p. 5-163, para. 2 and 3

256. - These paragraphs support the immediately above expressed concern over lack of knowledge of Labrador deep-sea benthos. Similarly, see conclusion on page 5-164, paragraph 4, which states there is insufficient information on benthic communities to form impact predictions. While some work has been done inshore (see paragraph 5) none has been undertaken offshore.

256. See response 255.

5.11.5 Economically Important Invertebrates
p. 5-170, para. 4

257. - Add to list of economically-low value species the arctic squid (Gonatus).

257. Addition accepted.

5.12 ICHTHYOPLANKTON p. 5-175, para. 1

258. - This paragraph clearly outlines one of the most important data gaps in the area of concern. The spatial and temporal distribution of fish eggs and larvae, both horizontally and vertically, and patterns of passive movement is prerequisite to any understanding of risk and development of contingency planning.

258. Agreed. This supports Section 8.6.6 of the IEA.

5.12.2 Seasonal Patterns ... Abundance
p.5-175, para. 2

259. - Here we see another critical knowledge gap which should be addressed, the location of principal spawning areas of Labrador marine fish species.

259. See response 258.

p.5-176, para. 2

260. - The assumption that developing cod eggs and larvae drift southward with the outermost band of the Labrador Current is critical to determination of distribution of eggs and larvae in time and space; this assumption should be tested by field study.

p.5-177, para. 3

- Known distributions of fish eggs and larvae are presently restricted to the period mid-July to mid-

September and as a consequence early and late spawning fish have probably been missed. A full seasonal distribution study is warranted, the difficulties posed by sea ice notwithstanding.

260. See response 258.

Table 5.22 p. 5-178

261. - Reference to lemon sole is archaic. Commonly referred to as Winter flounder, *Pseudopleuronectes americanus*.

261. We stand corrected.

5.13.2 Groundfish

Arctic Cod p. 5-195, para. 2

262. - The lack of knowledge concerning the general distribution and biology of the arctic cod in Labrador waters is truly a data gap that should be addressed given that the species is one of the most abundant and is probably critical in food webs of the general area.

262. Some information on the biology of Arctic cod is available from EAMES work. Historically, work on forage species such as capelin and sand launce has been done by DFO; perhaps Arctic cod should be added to this list.

5.13.3 Anadromous and Catadromous Fish
p. 5-197, para. 2

263. - The American eel is the only catadromous fish in the area!

Atlantic Salmon p. 5-198, para. 1

- Re: "British" salmon at West Greenland: this should read "European" salmon.

para. 2

- Re: the capture of adult salmon over ocean depths by gill nets, it should clearly be stated that this is during research cruises only. There is no commercial fishing for salmon in the open Labrador sea.

263. Corrections noted.

5.14 THE LABRADOR COMMERCIAL FISHERY

264. 5.14.1 Effects of Environment on the Fishery
p.5-208, para. 1

- See comment made on Executive Summary regarding southern limit of these species.

Table 5.23 p.5-212

- Trouts (NS) should be "(Salvelinus spp.)" not "(Salmo spp.)"

264. Corrections noted.

6.0 ENVIRONMENTAL IMPACTS AND MITIGATING MEASURES

6.1 The Nature of Impact Assessment
p.6-1, para. 2

265. - Since more severe chronic impacts can occur during production (i.e. release of processed water, spills, etc.) than generally occur during exploration, I suggest deletion of "production" in line 5. In fact, chronic impacts can equal or exceed catastrophic impacts in the case of production.

265. Comment noted. Its point is speculative.

6.2.2 Disposal of Drilling Fluids p. 6-3 to 6-9

266. - The referenced study by Ecomar (1978) on the effect of drilling fluids on the marine environment is not particularly relevant to Petro-Canada's drilling program off Labrador. In the Ecomar study a total of 4332 bbl. of mud and cuttings were released over the life of the well. The vast majority of this would be cuttings by both weight and volume. The total mud discharged was only a small fraction of the 4332 bbl. Petro-Canada, on the other hand, estimates that 7500 bbl. of mud (i.e. drilling fluid) per se would be released during the drilling of a "standard" Labrador Sea well. It is suggested that Petro-Canada conduct similar assessments to those conducted by Ecomar. The assessments, done at selected drill sites over varying ocean depths, are necessary in order to categorically state that drilling fluids have "slight and localized impact on marine life".

266. **The study recommended is a low priority item at present. Recent literature on this subject is extensive. Probably, still further studies of this sort are unnecessary. Important references that confirm this are: 1) Symposium on Research on Environmental Fate and Effects of Drilling Fluids and Cuttings, Lake Buena Vista Florida, Jan 21-24, 1980. 2) Report on Offshore Oil and Gas Drilling Fluid Disposal in the Canadian North.**

6.2.5 Accidental ... and Chemicals p. 6-12, para. 2

267. - We assume though there have been accidental spills. If this is indeed the case, some data should be provided on the type, extent, and duration of these spills.

267. **Comment noted.**

6.5.6 Weathering of Oil p. 6-27, para. 5

268. - It is not sufficient to generalize that light oils evaporate faster. Pour point and ambient temperature are also critical. Consider the case of Hibernia crude, given its pour point, spilled during winter when sea temperatures are 0 to -1.5°C. How quickly does it evaporate under these conditions even though it is a very light crude oil?

268. **Agreed. A major point of Section 6.5.6 is that a great number of processes affect the rates of weathering of oil.**

6.5.7 Slick Trajectory ... Labrador Sea p.6-33, para. 4

269. - Granted acutely toxic fractions would be completely weathered given these environmental conditions but how about oil spilled in winter? In any event, sublethal concentrations would persist quite extensively beyond 125 km of the well head.

269. **The IEA does state clearly that the slick trajectory model is not applicable when pack ice covers the sea surface.**

6.6.1 Water Quality p.6-36, para. 1

270. - The last sentence in this paragraph is incorrect and worse, misleading (see also my comment on Section

1.6.6 of Executive Summary)! Hundreds of ppb (up to 300) are not uncommon under an oil slick and levels in this range can be acutely toxic to fish larvae. Newly spilled fresh oil at 200-300 ppb has a good proportion of toxic, lower molecular weight components. Concentrations at the slick-water interface often are in the low ppm range. Recent DFO research (Kiceniuk pers. comm.) has demonstrated sublethal effects in adult fish at 50 ppb for Hibernia crude.

270. A more careful reading of all of Section 6.6.1 would support the conclusion reached in the offending sentence.

6.7.1 Introduction p.6-46, para. 1

271. - Re: line 9: add "and planktonic larvae" after "eggs".

- Re: line 11: insert after "benthic organisms" - "herring".

271. Corrections noted.

para. 2

272. - This paragraph correctly identifies trophic relationships and species interactions as poorly understood for the Labrador Sea (in spite of comments to the contrary elsewhere in the document). Determination of these relationships and interactions is vitally important and should be considered a critical gap in knowledge to be filled.

272. Agreed in principle. This is not an industry priority at present, however.

6.7.2 Microbiota p.6-46 to 6-48

273. - Virtually nothing is known of the potential for oil degrading by oleoclastic bacteria in the Labrador Sea water and sediments; this should be considered priority research both in terms of contingency planning and biological monitoring.

273. Agreed in principle. However, the work of Bunch (1979) in south Davis Strait should be applicable to Labrador.

6.7.3 Phytoplankton and Macroalgae

274. - In view of Grainger's (1975) prediction, I suggest my earlier comments on the need for research on epontic algae in the Labrador area are well founded.

274. See response 253.

6.7.5 Fishes p.6-60, para. 2

275. - The distribution patterns of ichthyoplankton are critical to any impact assessment or contingency planning. See my earlier comments suggesting this is a major research priority.

275. See response 258.

p.6-61, para. 3

276. - Re. line 3: I do not agree that damage to ichthyoplankton "cannot be estimated". It can certainly be estimated; accurately determining it quantitatively may be another question!

276. A major element in Dr. Wiseman's commentary until now is that very little is known of ichthyoplankton distributions. Likewise, the spreading, thickness, patchiness and degree of emulsification cannot be predicted with certainty.

277. - Re. line 4: It's not the depth of spawning that necessarily determines risk to eggs and larvae but rather distribution of them in the water column.

277. Agreed.

278. - Re. line 6: Yes - there probably would only be "very low" concentrations of dissolved hydrocarbons at great depths and at the bottom. However, concentrations of oil in sediments could be considerable and effect sublethal responses.

278. The speed, concentration, and extent of incorporation of hydrocarbons into bottom sediments can only be guessed at. This comment is speculative.

279. - Re: lines 10-11: The proportion of eggs/larvae that might be affected indeed cannot be predicted at this time given current information. The necessary information has never been collected; this is why we need it now.

279. See response 258.

p.6-63, para. 3

280. - There is much more recent literature on hydrocarbon detoxification in fish by Payne and Payne _et al_.

para. 5-7

- There is more recent and pertinent (N.W. Atlantic species) work on sublethal effects in fish by Kiceniuk and Kiceniuk _et al_.

p.6-64, para. 2

- Hydrocarbons may also act as mutagens.

280. Comment accepted.

6.8 OIL SPILL SCENARIO FOR THE LABRADOR SEA

p.6-73, para.2

281. - Based on Petro-Canada's knowledge of formation characteristics encountered to date, the oil flow rates would indeed be less than that used in the LeDrew and Gustajtis scenario. However, should the operator encounter a Hibernia-class field on the Labrador Shelf, then a spill of 25,000 bbl./day is quite plausible.

281. Petro-Canada disagrees. Remember, this scenario is based upon exploratory drilling. Our drilling engineers insist that fluid mechanics place a finite limit jon the amount of fluid that can flow through a borehole of a given diameter at a given time. Ergo, the figure Dr. Wiseman quotes may well apply to a production well, but not an exploratory well.

paras. 3-5

282. - LeDrew and Gustajtis may very well have underestimated weathering rates of the oil in their scenario, however, the Seaconsult trajectory analyses do not include weathering estimates during ice periods either. In effect, the estimates of weathering by LeDrew and Gustajtis may not be all that inaccurate considering the dampening effect of ice. Similarly, the Seaconsult analyses do not consider the movement of spilled oil under the ice pack but rather in open water where wind dominates current. The optimistic analyses may not apply during ice cover where the effect of wind is eliminated.

282. All these points were developed in Section 6.8 of the IEA. Careful reading of this Section would indicate that the estimates of LeDrew and Gustajtis are pessimistic.

Pelagic Invertebrates p.6-75, para. 4

283. - Squid (short-finned) do not breed anywhere near Labrador. Only a slight fraction of total N.W. Atlantic stock would be exposed to an oil spill in the area. Therefore, the effect would be slight not moderate.

283. We stand corrected.

284. - No mention is made here of the larvae of invertebrates which are found at or near the surface.

284. Agreed. The OLABS work of Buchanan and Browne (1981) was not completed when the IEA was being written.

Benthic Organisms p.6-76, para. 2

285. - While I agree that toxic concentrations in the water column at depths of 200 or more meters are unlikely, there could be concentrations in the sediments that could prove sublethal.

285. Speculative. See responses 255 and 278.

Fishes p.6-76, para. 7

- Re. line 2: add "adult" after "on"

286. - Reference should be made here to possible sublethal effects upon fish that are in intimate contact with sediments (i.e. flounders).

286. Speculative. See responses 255 and 278.

p.6-77, para. 1

287. - This suggestion is naive and misleading. It assumes unlimited habitat for these displaced fish and unlimited food supply. What if there are already fish there when these displaced fish get to this unspoiled area?

287. Even a large oil slick would occupy a small proportion of the Labrador Sea, and it is difficult to imagine that vast areas would be unavailable to demersal fishes. Is Dr. Wiseman invoking territoriality or some other behavioural phenomenon that would prevent "displaced fish" from entering the home ranges of resident fishes?

Marine Mammals p.6-79, para. 2

288. - Wouldn't sheltered bays accumulate oil and wouldn't weathering be reduced here? It would make harbour seals more vulnerable, not less vulnerable.

288. Perhaps. It is still hard to imagine more than a slight impact, because of the harbour seal's widespread distribution and migratory behaviour.

para. 3

289. - Walrus are particular about their choice of haul-out areas; what if they were oiled?

289. The point the IEA makes is still valid: the walrus' centre of distribution lies to the north and west of Labrador.

8.0 PAST, PRESENT,...OFF LABRADOR

8.2 Results of the OLABS Program p.8-2, para. 3

290. - Re. ABS work on biological and chemical oceanography: in addition to being limited during the July to September period, it did not fully cover off the highly productive shelf-break areas. Extension of seasonal coverage and continuation of study transects out over the shelf-break is an important research need.

290. This point was raised in the review seminar. There are logistical and time limitations to the area that can be sampled in one field season.

para. 4

291. - The benthos and macroalgae work of Barrie *et al*. was indeed elucidating relative to intertidal and immediate sub-tidal communities. Similar efforts are needed on deep water communities.

291. See response 255.

para. 5 and para. 2
p. 8-3

292. - While the food and feeding study by De Graaf *et al*. was important it was little more than scratching the surface. I strongly disagree that as a consequence of this study, literature reviews, and fishermen interviews that there is "a relatively good qualitative understanding of the trophic relationships of the Labrador Sea fishes". I believe we have a long way to go yet before we can make that statement when we can't even make it for the Grand Banks.

292. **Opinion noted. If this is so, how much feeding information is "enough"? Assuming that DFO, the Russians, and other scientists ever do reach some ideal state of knowledge, how would this information affect industrial operating procedures, oil spill countermeasures or even fisheries management?**

8.4 EVALUATION....OFF LABRADOR p.8-7, para. 1

293. - The initiative taken in 1981 regional study of the physical environment is applauded. Now, if we can only generate support for a similar effort in biology to go hand-in-hand with physical studies.

293. **Sections 8.6.6 and 8.7 of the IEA recognize the value of integrated studies.**

p.8-8, para. 4

294. - The "need-to-know" regarding surface water circulation over the Labrador banks as it relates to slick trajectory forecasting is equally applicable to eggs/larvae "trajectory" forecasting.

p.8-9, para. 1

- Background spatial variation in hydrocarbons and heavy metals is indeed missing and should be addressed. Similarly, background documentation of oleoclastic bacteria is necessary.

294. **Section 8.6.6 of the IEA supports this.**

p.8-10, para. 2

295. - Not only are present data inadequate for contingency planning and countermeasures refinement but more important, they are inadequate for quantitative impact prediction.

295. **"Quantitative impact prediction" is only a means to an end, not an end of itself. Unless impact prediction leads directly to pragmatic ends (i.e. what to do or not do), it is essentially a pointless academic exercise. Given the limited repertory of mitigative and spill response techniques, the need for quantitation is questionable. See response 250.**

8.5.1 Introduction para. 2

296. - The comment immediately above is pertinent here. One of the priorities for future studies should be the

"need to predict impacts upon the ecosystem quantitatively". This is prerequisite to any prevention or mitigation as the first priority implies.

296. See response 295.

para. 4

297. - I cannot support Petro-Canada's hope that the fishing industry and the regulatory agencies "will support the greater proportion" of environmental assessment-related studies in the future if this is what is implied. Environmental assessment and impact study is clearly the responsibility of the proponent. Study of processes leading to an understanding of impact is a regulatory agency responsibility as it clearly relates to its management responsibility as well. Similarly, the regulatory agency has a major role to play in monitoring and development of monitoring techniques and approaches.

297. See response 246. A major conclusion of the IEA, supported by the review seminar, is that offshore petroleum operations are likely to cause localized, reversible and environmentally tolerable changes to the marine environment during the course of day-to-day operations. The major concern is that an offshore oil blowout could occur, but there seems to be concurrence that the risk of a blowout is low.

It may be inexpedient for DFO to raise concerns about the impacts that the fishing and shipping industries daily cause to the marine biota. The fact remains that the petroleum industry operates under more rigorous environmental standards than do other elements of the industrial sector, bears more than its share of the burden of environmental research, and yet is viewed as something of a "bogey-man" by environmental regulatory agencies. The IEA makes a legitimate argument that other elements of the industrial sector should be required to share the responsibility for collecting environmental information and for minimizing environmental damage, and that government should fulfill its mandate to collect and publish baseline environmental information.

Objective II p.8-12, para. 4

298. - I strongly suggest the inclusion of environmental assessment as a priority for rationalizing research.

298. See response 295 and 250.

8.6.1 Physical Oceanography p.8-16, para. 3 and 4

299. - I'm not sure I can see the value of opportunistic, ad hoc observations made from fishing vessels. We've more or less abandoned any thought of such observations from supply vessels. Perhaps there is some value.

299. Perhaps this could be made a regulatory requirement of the fishing industry, which operates in the area during winter, and which would be the most direct beneficiary of this information.

8.6.2 Chemical Studies p.8-16, para. 5

300. - Delete "surface waters" and replace with "water column and sediments".

300. Agreed.

8.7 CONCLUDING REMARKS p.8-23, para. 1

301. - While the Grand Banks environment may be better understood than that of offshore Labrador, we must keep in mind that the Grand Banks are really poorly understood. I do not at all agree with the suggestion that the OLABS research has "contributed significantly to the understanding of environmental processes in the Northwest Atlantic". Baseline survey-type knowledge - yes! Process knowledge - no!

301. Opinion noted.

para. 2

302. - Regarding criteria for research support by the Labrador Group: surely research oriented toward specific, critical environmental assessment/prediction is supportable.

302. See responses 295 and 250.

3.2

OSS ATLANTIC

Review of

Petro-Canada's Offshore Labrador Initial Environmental Assessment (IEA)[1]

INTRODUCTION

Part I lists the detailed comments of individual reviewers on those specific sections of the IEA for which there is expertise in OSS Atlantic. Part II contains a brief overview of the IEA by R.F. Addison of the Marine Ecology Laboratory (MEL), OSS Atlantic, which summarizes the general impressions of the document.

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OSS Atlantic
Bedford Institute of Oceanography
(902) 426-3246
20 April 1982

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[1] Anon. 1982. Offshore Labrador Initial Environmental Assessment. Petro-Canada. 568p.

PART I

Detailed Comments

Ice and Icebergs -- Sections 1.5, 3.3.2, 5.3.9, and 5.4
(Reviewer: S.D. Smith)

The descriptions of physical properties of pack ice appear to be a competent summary of information available in atlases and from government and industry sources.

303. Two areas of weakness require further work. The strength, thickness and types of ice are discussed separately, but not in combination. Section 5.4.2 gives hardly any useful information of how ice limits the working season by area and type of vessel or activity. This could perhaps be addressed in a greatly expanded Section 3.3.2. The effects of winds and currents and the resulting pressure within the ice should also be considered. Small ice floes at the ice margin may be tossed by breaking waves and may pose a special hazard to exposed valves, plumbing, portholes, etc.

A second area of weakness is the lack of information on variability of ice conditions from year to year or over periods of several years. Sea ice is very sensitive to fluctuations in climate and the possibility of several heavy ice years in a row contributes to the technical and economic risks inherent in operations off Labrador. Presumably there is a risk of about 1 in 10 of encountering a cold decade like that of the 1890's, while most of our data are from the relatively benign climate of the past 30 years. Fig. 3-5 (page 3-12) should show ice limits for lightest and heaviest ice years as well as "normal" ice limits, and should be mentioned in Section 5.4.2.

The sections on icebergs have similar deficiencies. The data on distribution of iceberg sizes and numbers should be combined to map the probability of collision with a fixed object of, say, 300 m size. The separate statistics given do not readily yield this information, which is pertinent in considering the positioning of fixed structures or of bottom-mounted equipment. Again, no mention of year-to-year variation in iceberg numbers and sizes is given. Drilling experience over the past two years should be judged in the context of longer-term records. A few years (1929, 1945, 1972, 1974) have had 3 to 5 times the mean annual number of icebergs according to IIP.

303. Criticisms noted. Please note that worsening sea states, not sea ice, may be the limiting factor for late-season exploratory drilling.

304. It is generally believed that considerable research remains to be done on the reliability of radar detection of icebergs and on prediction of their drift tracks. Special attention should be given to this research, since icebergs are a unique feature of the Labrador environment while other environmental conditions such as waves and low temperatures are probably no worse than those in some other offshore petroleum fields.

304. This comment supports major research recommendations of the IEA, and of the review seminar.

305. Section 5.3.9 (page 5-64) on iceberg scouring contains very little quantitative information. An indication of potential hazards is needed if this initial document is to be of value in deciding on locations for site-specific studies. DFMR/AGC staff will probably comment on this section.

305. It is agreed that the data on scouring could be strengthened. Such data would be especially useful during production, when permanent bottom-founded installations or pipelines could be required.

Physical Oceanography -- Section 5.6 (Specifically 5.6.2, Water Masses and 5.6.3, Currents)
(Reviewer: J.R.N. Lazier)

306. This is a short description of the water masses and currents over the Labrador Shelf and Slope. The work is based for the most part on previously published work, however, some of the current meter data collected by Petro-Canada is summarized. The main features of the water mass distributions follow Dunbar (1951) and Templeman (1971) and the current structure follows closely Smith *et al*. (1937) and Matthews (unpublished). The direct current-measurements from the drill ships, and from Bedford Institute of Oceanography and Petro-Canada work, are used to describe the differences between the swift steady flow on the Slope and the slower fluctuating flow over the Banks. The work is an honest general review of the ocean conditions, adequate for an initial environmental assessment.

The company is presently processing observations from a large survey of the area in 1980. I expect these data will provide better understanding of the details of the processes that will affect oil production.

306. Comments noted.

Physical Oceanography -- Section 5.6 (Specifically 5.6.4, Waves)
(Reviewer: H.J.A. Neu)

307. The writer of this chapter is well acquainted with waves but the data he uses are not the best and latest. He seems to be aware of this but does not attempt to evaluate the quality of the different sources. He uses BIO results, but primarily for confirming the results of others.

McCulloch's data (AES) are used for demonstrating the seasonal variability of wave height and wave period (figures 544 and 545 for wave heights and figures 546 and 547 for periods). Though we in BIO would have dealt primarily with periods of large waves, we agree in principle with the analysis of the periods. We disagree, however, with the wave height results as presented, since they do not relate to a point in the ocean but are based on the stipulation that the height of the highest wave in a 5 degree grid area prevails over that area: in reality there usually exists a great variation. Such an approach results in wave heights which are too high for design and operational purposes.

Extreme wave heights predicted for offshore Labrador by two sources are given in Table 5.18. We copied the table and added the BIO results, now based on 11 years data, underneath (refer to Annex to Part I). As can be seen, the BIO summer data are appreciably lower than given by Petro-Canada while the winter data have similar values. This can be important for planning summer operations.

Not listed in our table are the largest H^{sig} for a normal year, a 10-year time span and the predicted values for 50 years and 100 years. They are for the areas as follows:

	1	10	50	100	years
E6	8.6	12.1	14.8	16.1	m
F5	8.9	13.3	17.0	18.7	m

These values are somewhat higher than the December values of Petro-Canada.

It should be noted that E6 and F5 are more or less affected by Labrador pack ice from December to July, thus winter, annual and long-term statistics are influenced by ice cover. For any final analysis, the adjacent areas E7 and F6, which are free of ice, should therefore be compared with E6 and F5 particularly for long-term predictions. A still better solution, which we apply in BIO, is a spatial analysis of the wave height distribution which includes the entire Labrador Sea and the Grand Banks area.

307. Comments noted. Petro-Canada appreciates this new information.

Chemical Oceanography -- Section 5.7
(Reviewer: E.P. Jones)

308. The document does not have much chemical information in it, reflecting the general lack of such information along the Labrador coast. What discussion there is appears honest and accurate with little attempt to mis-interpret or over-interpret data. Some unpublished nutrient and oxygen data from BIO cruises 77-029 and 78-002 are not included in the IEA. These are available for inclusion in later documents if desired.

I would be a little careful about drawing conclusions regarding nutrient renewal processes from nitrate-to-phosphate ratios (page 5-140). Since nitrate-to-phosphate ratios are not more than 10 in Baffin Bay and are around 13 to 14 in some of the deeper parts of the Labrador Sea, the fact that on the Labrador Shelf they are below 15 is perhaps not conclusive. So far as I know, renewal processes on the Labrador Shelf are not yet well un erstood.

I found no obvious omissions in the bibliography.

Overall, I think the document is well done.

308. Comments noted. The unpublished information would be a welcome addition to Petro-Canada's archives.

Chemical Oceanography, Pollution -- Sections 5.7, 6.3 and 6.5
(Reviewer: E.M. Levy)

309. Although this is an "initial" environmental assessment, it is by far the best prepared and most conscientious of

any I have reviewed so far. My only criticism of the sections that I have read in detail is that much of the information is based on data pertaining to temperate conditions and might therefore be questioned on the grounds of relevance to the Labrador Sea. Nevertheless, there has been a concerted effort to assemble existing information regarding the effects of the industry on the environment and conversely. While it does not completely address all conceivable questions, this document is a major step in the right direction.

Section 5.7, Chemical Oceanography, underlines the poor state of the existing data base and understanding of the chemical oceanography of this region. (BIO has unpublished data concerning salinity, dissolved oxygen, alkalinity, nutrients, dissolved/dispersed petroleum residues for a portion of the Labrador Sea but not for the Labrador Shelf). Background levels of dissolved/dispersed petroleum residues in this area would be of great benefit to both industry and government.

309. Comments noted. Thank you.

310. Section 6.3, Contribution of Oil Blowouts to Oceanic Pollution, is based on pre-IXTOC information and should be updated. This section contains a lot of speculation concerning blow-out probabilities and seems to be of rather little use as equally valid but quite different conclusions can be reached by using a different set of assumptions. Similarly, the section on the behaviour of oil and ice (Section 6.5) contains considerable conjecture.

310. Agreed. When the IEA was being written, there was discussion within Petro-Canada about the value of risk analyses. Because each oil play has a unique combination of meteorological, oceanographic, and geotechnical risks, predictions based on historical analyses may have limited predictive value.

Fortunately, there has not yet been a blowout of oil under ice in Canada. The information that exists relates primarily to experimental releases of oil under fast ice; hence the behaviour of oil under shifting pack ice is relatively poorly understood.

<u>Primary and Secondary Producers -- Sections 5.8, 5.9 and 5.10</u>
(Reviewer: G. Harrison)

311. Sections 5.8, Microbiota, 5.9, Primary Producers, and 5.10, Zooplankton are brief but make a generally ade-

quate assessment of the existing knowledge about primary and secondary producers in the Labrador Sea. However, some statements (implications) made are not supported in the literature. For example, the implication that phytoplankton are fast growing in the Labrador Sea (5.9.2.1, page 5-150) is not backed by measurements (e.g. Irwin *et al*., 1979a, b loc cit.). In addition, the suggestion that chlorophyll distribution is regulated primarily by light (page 5-155, para. 4) may also be premature. Sea water density ($_T$) is more likely accounting for the vertical distribution of phytoplankton (see Harrison *et al*. 1982, Can. J. Fish. Aq. Sci., 39).

311. Comments noted. The hypothesis that stratification, not light intensity, regulates chlorophyll distribution appears to be a new concept in biological oceanography.

312. There are words (sentences?) missing at the bottom of page 5-155 and top of page 5-156. Finally, no mention is made of Apollonio's work on ice flora in the Eastern Arctic (e.g. Apollonio, 1965, Arctic, 18).

312. Omission noted.

Benthos -- Section 5.11
(Reviewer: D.L. Peer)

313. I have read this and most of it seems ok, but there is a confusion of terms in the second paragraph. The three broad categories listed here are not analogous. The first category, "infauna" refers, as they correctly state, to animals buried in soft mud or sand. It is however part of a two-way classification that includes "infauna" (animals living buried into the sediment) and epifauna (animals living on or near the sediment surface). The second category is "sessile" which quite simply means that they don't move; they could be infauna or epifauna. The third category given here is "epibenthic". This term is used to describe animals living on, or attached to, the bottom; in other words the epifauna. This is used to distinguish between the above forms and the "hyperbenthic" forms which are the active swimmers that remain in close association with the bottom.

This criticism may sound trivial but they do use the terms epifauna and infauna in the text and they seem to be used correctly. For this reason they should be defined correctly in the beginning.

313. Semantical errors noted.

314. Also on page 5-165 the third line should read "zooplankton production to benthic production".

314. Correction noted.

Ichthyoplankton, Marine and Anadromous Fish, the Labrador Commercial Fishery -- Section 5.12, 5.13 and 5.14
(Reviewer: S.R. Kerr)

The above sections give an adequate (but not exhaustive) review of published information.

315. My main comment echoes the point raised by Brodie (see below). It is remarkable the degree to which the text is supported by reference to the "gray literature" of other consultants' reports, rather than by reference in text to the original publications. I raise this because I can see considerable risk of distortion and confusion if this trend continues.

315. Agreed. The usefulness and accuracy of the "grey" literature was an area of contention in the review seminar. The grey literature is sometimes the only source of information for certain topics, because neither government scientists nor consultants have felt their information is definitive or novel enough to publish in refereed journals. Unfortunately, the grey literature does tend to quote itself incestuously and errors can magnify. Also, rigorous peer review is often lacking. In summary, the grey literature must sometimes be used for want of published information, but judiciously.

316. Secondly, although the picture given seems adequate, there is a lot of information not reviewed, some of it in the primary literature, but a great deal of it is in NAFO publications, etc. Whether inclusion of any of this material would significantly alter the picture I do not know, although I doubt it, but this is my reason for use of the term "adequate".

316. Comments noted. Are CAFSAC and NAFO publications a part of the primary ("white") or the "grey" literature?

317. As always it appears to be the larval fishes that would be at greatest risk from an oiling event, but whether we could ever establish a significant connection is another question.

317. Agreed.

Marine Mammals -- Section 5.16
(Reviewer: P.F. Brodie)

318. Grey seals -- there is no evidence for breeding along the New Brunswick shore. They do not return to the breeding sites in any numbers until sexually mature, (page 5-259).

Harp seals nurse their pups for two rather than three weeks, (page 5-260).

318. Corrections noted.

319. Beluga immigrate to shallow river estuaries during the late July to early August calving period but not to fjords, as stated, (page 5-264). In general, the information on the other species of whales is not up-to-date. As more and more environmental studies are compiled by consulting firms they tend to turn inward, referring mainly to each others' studies for reasons of speed and economy. It would seem that it is time to look outward at the original and more recent data. The scientific reports of the International Whaling Commission are published yearly with the most up-to- date research and stock assessments. These, combined with CAFSAC and NAFO documents would be more refreshing and add body to these rather similar environmental studies.

319. See responses 315 and 316.

320. The following statement in that part of the Executive Summary dealing with marine mammals (page 1-12) is also questioned:

"The controversy surrounding the Newfoundland sea hunt has hindered the publication of data on the numbers and population dynamics of seals".

All research findings on harp and hooded seals (up to the 1981 research season) are readily available as NAFO research documents and, in fact, are more readily available because of the controversy.

320. We stand corrected.

Environmental Impacts and Mitigating Measures -- Section 6
(Reviewer: R.F. Addison)

321. The point made at the opening of this section, that contamination derived from hydrocarbon drilling, etc., activities, can be considered to be "chronic" or "catastrophic", is reasonable. The analysis of the "chronic" effects is well done, and the conclusions are fairly expressed.

321. Thank you.

322. I find the analysis of "catastrophic" effects less persuasive. Thus, blowouts are considered to be a minor source of contamination, in comparison with "chronic" sources like tanker pumping, etc. But surely the point could be argued that a blowout, because of its "catastrophic" nature, will have quite different (qualitative speaking) impacts on ecosystems, such as more intense exposures for shorter periods? I suggest that this view could be considered in any future documents.

322. Agreed. In fact, this distinction is made in a forthcoming IEE for West Coast exploratory drilling.

323. I am not sure how valuable are the lists of LC-50 values of oil towards various organisms. I do not question the validity of the data, but rather the tendency to look at ecosystem components in isolation. We know that they don't function in this way; components interact with other components, and it is these interactions which are important in maintaining the structure and functioning of the system. Yet these interactions are not dealt with in any detail in this section. In short, there seems to be little synthesis of the data collected in this section.

323. Agreed in principle. However, it would require a quantum leap to synthesize the disparate environmental information in the Labrador IEA into a comprehensive view of oceanographic processes. Such a synthesis would be full of speculation and untestable hypothesis. Yet another leap of the imagination is required to interpret the effects of an hypothetical oil spill upon an open ecosystem whose functioning is poorly understood, if at all. It is debatable whether an environmental assessment document is the proper forum for such synthesis, speculation and opinion. The review seminar's response to the relatively timid speculations in the oil spill scenario reinforces this conclusion.

ANNEX TO PART I

Table 5.18 Predicted extreme significant wave heights (m)
*(Sources: 1. Marex 1977 from waverider data
2. Group Five 1978 hindcast:
a) 57°19'N, 59°55'W
b) 54°20'N, 55°10'W)
3. BIO Area E6
4. BIO Area F5

Return Period (Years)	June	July	Aug	Sept	Oct	Nov	Dec	Source*
1	6.7	6.0	6.0	8.2	9.1	9.2	---	1
10	8.8	7.7	7.6	10.2	11.0	11.3	---	1
		---	---	6.3	7.9	10.5	11.6	2a
	---	---	---	8.8	11.1	10.0	12.4	2b
50	10.1	9.0	9.0	11.7	12.5	12.0	---	1
	---	---	---	7.8	9.5	13.1	14.4	2a
	---	---	---	11.3	14.1	12.3	15.2	2b
100	---	---	---	8.4	10.2	14.3	15.5	2a
	---	---	---	12.3	15.3	13.3	16.5	2b
	BIO Wave Climate Based on 11 Years Data (1970-1980)							
1	4.1	3.3	4.1	5.1	6.8	6.9	7.4	BIO-E6
	Ice	3.1	4.0	4.9	5.6	7.0	7.4	BIO-F5
10	6.0	4.6	5.9	7.3	10.0	10.0	10.5	BIO-E6
	Ice	4.2	5.7	7.1	8.3	10.7	11.1	BIO-F5
Long-Term Prediction Derived from Log-Normal Probability Model								
50	7.4	5.6	7.3	8.8	12.4	12.2	12.8	BIO-E6
	Ice	5.0	7.1	8.7	10.2	13.5	13.9	BIO-F5
100	8.1	6.0	7.9	9.5	13.6	13.3	13.9	BIO-E6
	Ice	5.3	7.7	9.5	11.1	14.8	15.3	BIO-F5

PART II

Summary of Overall Impressions by R.F. Addison

324. Section 5 seems to be largely a review of existing literature and reports. Most reviewers felt that this was an adequate description of the biology (and Physics, Chemistry) of the Labrador Shelf, but some pointed out technical slips or misinterpretations of data (see individual reviews). Some reviewers also noted the increasing trend for reports such as this to refer to the "grey" (usually consultant report) literature. Although the data from these sources may be reliable, such reports simply do not have the same degree of critical refereeing and therefore assessment of the validity of data as do papers in the "open" literature.

324. See response 315.

325. Much of the information was not presented in a form useful to the assessment of the impact of drilling operations on marine ecosystems. I think that this reflects the absence of much synthesis or interpretation of the data presented. The impact of oil on ecosystem components, for example, is assessed by treating each component in isolation -- yet we know that ecosystems just don't function as a collection of isolated components. Instead they interact, and it is the interactions -- and possible changes in the interactions -- which are important. However, I recognize that this document is an Initial Environmental Assessment, and I would expect that any subsequent documents will address this question of interaction. I suspect that this will not involve more data collection, but more interpretation of existing data. I admit that it is more difficult to assess the impacts on integrated interacting systems than on their isolated components, but the attempt has to be made.

In short, I see this document as a preliminary assembly of data on which to base an EIS. In its present form, the document is valuable, because it collates fairly comprehensively a large amount of scattered information. It is excellently written and presented -- I found Sections 3 and 4 to be a clear and fascinating account of the engineering aspects of the operations. But it needs more interpretation, particularly in Sections 5 and 6, to form the basis of a useful EIS.

325. See response 323.

G. McKinnon
Fish Habitat Management Branch
DFO (Ottawa)

326. Petrocan should be commended for bringing this material together and presenting it to government at this time. Since the document does not fit neatly into the EARP review process (i.e. it is neither an IEE or EIS) it requires some subjective judgement as to what should be included. I'm not sure whether the document is meant to provide a summary and synthesis of data collected under the OLABS program or whether it's more than that - a sort of preliminary EIS. If it is the latter obviously a full-blown EIS would require more site-specific information relative to production facilities.

There are some deficiencies in the offshore Labrador IEA which I think are notable.

326. Comments noted. Although it is not a decision document, the Labrador IEA has a similar structure and function to an IEE under the EARP process.

327. 1. No mention is made of the use of dispersants, their toxicity and overall impact on the environment. Similarly, a review of mechanical cleanup techniques and ability of these to reduce impact should be included.

327. A brief discussion on the effects of dispersants and dispersant/oil mixtures on organisms might have been useful. The BIOS program will probably contain information applicable to Labrador; however results of this program are not yet fully analyzed.

328. 2. The effects of sedimentation of oil on sensitive habitats is not considered to a sufficient degree. Most impacts on organisms are considered only in the direct sense and not in the sense of habitat loss, etc.

328. Presumably, this relates to the incorporation of oil into subtidal sediments, a process that appears to be poorly understood.

329. 3. The threat posed to operations off Labrador by icebergs is not dealt with adequately. A number of questions remain:

329. A more complete listing of the effects of icebergs on offshore operations is in the proceedings of the review seminar.

329a. a) Are there problems with iceberg towing technology in high sea states?

329a. Under existing procedures, sensitive operations would be suspended during high sea states.

329b. b) Are there problems with iceberg tracking under certain weather conditions? How predictable are the movements of icebergs?

329b. Iceberg trajectory modelling is a technology that still could be improved.

329c. c) Are there critical times when a rig is unable to move off-site without threatening the integrity of the well?

The Baffin Bay IEA produced by PetroCan indicated that "as many as 40,000 icebergs are produced every year from Greenland glaciers". This would seem to present an enormous problem in the Labrador Sea given the weather conditions which exist there.

329c. Yes. But sensitive operations would not be commenced if iceberg threat were imminent, or if weather forecasts predicted worsening conditions.

330. 4. The effect of oil under ice is of obvious concern. While the deficiency is noted in the IEA, its importance should not be underestimated.

330. Agreed.

331. 5. Much more ocean current and wind data should be collected so that slick trajectory models can be relied upon to be reasonably accurate.

Some specific comments follow:

331. Agreed.

<u>Section 1.3, page 1-3</u>

"The major geotechnical problem encountered off Labrador has been the presence of boulder lenses in seafloor sediments"

332. PetroCan should indicate whether boulder lenses present an environmental hazard as well, in terms of well control.

332. Our geotechnists believe that boulder beds create downtime, but not well control problems.

Section 1.62, page 1-13

- "Petro-Canada is aware of the harm that aircraft flights could cause to seabird colonies, and will instruct its carriers to avoid them".

333. This is all well and good in fine weather. What about in times of bad weather when safety may dictate otherwise.

333. Human life and safety are obviously the overriding concerns.

Section 1.63, page 1-13

"Although they are dramatic, oil blowouts during offshore exploration and production are relatively minor pollutors of world oceans"

334. The company makes much of this and its probably true in the context of the world's oceans as a whole but it doesn't diminish the significance of a possible oil blowout in the Labrador Sea.

334. Agreed. Obviously, the IEA's intention was not to minimize this concern: otherwise, it would not have devoted 66 pages to discussing the issue of oil blowout.

Section 1.65, page 1-14

335. The fate of sub-surface oil emulsions is not discussed.

335. See Sections 6.5, 6.6.1, and 6.7 for a discussion of this issue.

Section 1.66, page 1-15

"Oil tends to accumulate in low-energy environments".

336. These probably constitute the most important coastal habitats along the Labrador coast.

336. Agreed.

Section 3.3.2., page 3-11

"Future drilling units, especially dynamically-positioned semi-submersibles, will be able to stay on wells beyond mid-October, due to the units improved stability characteristics".

337. Does the ability of these units to move off-site quickly equal or exceed that of drillships? Also if round drillships are contemplated for use in the Labrador Sea as in the Beaufort Sea, these should be mentioned.

337. Because the dynamic positioning systems of semi-submersibles and drillships are based on similar principles, the disconnection procedures and times are comparable. "Round drillships" are not contemplated for exploratory drilling off Labrador.

<u>Section 5.6, page 5-107</u>

"Direct measurements of the currents have shown occasional periods of northward flow and often have shown rather vague directional tendencies"

338. This is an important point in relation to iceberg track predictability and oil spill trajectory modelling.

338. Agreed.

<u>Section 5.93, page 5-155</u>

"It appears that ichthyoplankton of various species are distributed in the upper few metres of the water column, where they may be vulnerable to surface oil for at least part of the year".

339. A discussion of the vulnerability of ichthyoplankters to sub-surface oil should be included.

339. This was done in Section 6.

<u>Section 6.5.5, page 6-27</u>

"More information is needed to predict the behaviour of oil following a blowout in the Labrador Sea".

340. This information should be collected prior to drilling, not just in advance of production. Much more detailed knowledge of ocean currents is required for accurate modelling.

340. Agreed. This is a continuing industry priority.

<u>Section 6.57, page 6-30</u>

341. I don't think that a lot of faith can be placed in these slick trajectory models given the lack of ocean current data on which they are based.

341. Opinion noted. Information on currents (and hence modelling capabilities) has improved considerably during the past two years.

Section 6.57, page 6-31

"Wind and currents are the only factors that affect slick trajectories".

342. If as stated on page 6-30 that "wave action would cause natural dispersion of oil by emulsifying it with water" then this too is a factor in slick trajectory and should be included in the model.

342. This comment misses the point. Winds and currents determine the trajectory of a slick; sea state, among many other factors, affect the weathering of this slick.

Section 6.7.5, page 6-61

343. The effect of oil in the sediments does not seem to have been taken into account as having a possible negative impact on fish or fish eggs.

343. See responses 255, 276 and 278.

3.3

OFFSHORE LABRADOR
INITIAL ENVIRONMENTAL EVALUATION

Review Comments By
Environment Canada

Introduction

The EIA is reasonably complete and comprehensive to the date of preparation. The information presented will form a good basis for the preparation of an Environmental Impact Statement at some future date. The reviewers have attempted to identify the areas where additional information is necessary to complete the data base. We realize that some of these topics may have been addressed in the OLABS Program.

344. The following recommendations for additional work have been identified:

344. Perceived research needs have been noted. A list such as this is a welcome indication of the work that DOE would like to see done. Some of these studies are applicable to the industry objectives as described in Section 8 of the IEA, others are less so. The sharing of costs, expertise, and manpower between government and industry is open to negotiation, the Environmental Studies Revolving Fund would be the probable mechanism.

345. 1. Additional information is required to improve weather forecasting abilities and hindcast wave data and more extensive rig data are needed.

345. Agreed.

346. 2. Additional information needs to be gathered and interpreted for the effect of the environment on the operations in the Labrador Sea.

346. Agreed.

347. 3. There appears to be a need to examine the phytoplankton biomass of the Labrador Sea since there is considerable difference between the Davis Strait, Frobisher Bay and the limited data available for the Labrador Sea.

347. Perhaps. The application of these results to spill response or mitigative techniques is difficult to assess.

348. 4. Given the percentage contribution of the epontic community to the total annual food budget of Frobisher Bay; epontic community work should be conducted in some of the larger embayments and fjords on the Labrador coast most likely to be oiled during a major spill.

348. Perhaps. See previous comment. Because fast ice acts as a barrier to surface slicks, studies of epontic algae under pack ice may be more useful.

349. 5. Since the copepod Calanus finmarchicus constitutes a major portion of the zooplankton of the Labrador coast, some oil toxicity work should be conducted with this species.

349. Perhaps. See response 347.

350. 6. During the proposed heavy metal studies additional work should be conducted on concentrations in benthic invertebrates and possibly histopathological work similar to that conducted by Canmar in the Beaufort Sea.

350. Doubtful. Results of the histopathological work done in the Beaufort Sea were inconclusive, because sample sizes were much too small, and data were difficult to interpret.

351. 7. Sea ice and icebergs are discussed at some length whereas the importance of landfast ice in dealing with a possible oil spill is not. Consideration should be given to commissioning a study to assess the nature and distribution of shorefast ice and its implications for the movement, fate and cleanup of an oil spill.

351. Not a priority. Fast ice is a barrier to the onshore movement of oil slicks, and the behaviour of oil under fast ice is well known from work in the Beaufort Sea. By contrast, little is known of the behaviour of oil under shifting pack ice.

Specific Comments

352. Some specific comments are given in the following:

Section 1.3, page 1-2

Even though they have superior rough weather characteristics, use of semi-submersibles off Labrador would be hampered by ice and iceberg conditions!

Page 1-3. While drilling procedures are standard off Labrador, there is a requirement to secure permission on a daily basis beyond mid October. A similar stipulation is not placed on drilling elsewhere on the east coast.

The statement that "a 216 mm. hole diameter is the one used to drill to total depth" needs clarification (see also page 3-5).

This section tends to downplay potential problems. I would also question if there is such a thing as "standard relief well drilling procedures".

Section 1.5.3

Page 1-5. According to Basham and Adams (EMR) in "Earthquake Hazards to Offshore Development on the Eastern Canadian Continental Shelves", there have been 4 earthquakes of magnitude 5 or greater since 1956. Basham also indicates that more than 5 x 10^{10} m^3 of sediment slumped from a 200 km. length of continental slope during the 1929 earthquake south of Newfoundland. It does demonstrate a potential hazard for offshore structures.

Boulder beds are mentioned elsewhere but not here in the section on seafloor sediments.

"Relatively small amounts of coastal sediments are present". In the text, it is made clear that there are locally important sediments, especially in Southern Labrador.

352. I would have thought that ice dynamics are more important in reworking sediments than suggested here. Considerable ice scouring is mentioned in the next paragraph.

Nowhere are "decadent tropical storms" defined.

352. Yes, but D-P semisubmersibles would have advantages over moored semisubmersibles.

Section 1.5.4: Climatology

"...during July winds are from the south". Better to state: "...during July southerly winds predominated".

353. Icing occurred most frequently during February at "OSV BRAVO". Is this representative of the entire Labrador Shelf?

353. Bravo is not representative of the shelf, but it does have a long period of record and reliable data.

Section 1.5.5: Sea Ice and Icebergs

354. Para 3 states that the maximum measured speed of ice flows is 1.0 metres per second while on page 5-71 one case of a speed of 1.2 metres per second is cited.

354. The comment is correct. This section should be adjusted to reflect the maximum of 1.2 m/s. Page 5-72 should also be corrected in line nine.

355. Para 4 - Deformation can cause an ice thickness much greater than 1 - 3 metres. First year ice growth can produce a thickness of 1 - 3 metres and multiyear ice can attain 6 - 9 metres thickness. These ranges are slightly high for normal growth and err on the low side as estimates of thickness values which can be attained for deformed ice. The statement does not agree with statements made in section 5.4.5.

355. With respect to multi-year ice, the figures quoted in the I.E.A. are mean thicknesses. As I read the two sections there does not appear to be a contradiction. Clarification could be made in 1.5.5 by adding "mean" as an adjective for ice thickness in the first sentence.

Section 1.5.6: Physical Oceanography

"Waves as high as 15 metres could occur every 50 years". Perhaps better to say:

356. "Statistics place a 50 year return period on 15 metre wave heights".

In point of fact waves of this height might occur twice a week, however probabilities do not favour such an event.

356. For those executives unfamiliar with "return period", this could read "waves higher than 15 meters are unlikely to occur more often than once every 50 years".

Section 1.5.9: Page 1-8

357. Seaweeds still require suitable areas for "hold-fasts" hence sheltered areas (with sediments) are not necessarily good for such plants.

357. Comment noted.

Section 1.5.11: Page 1-9

358. I question the differentiation between "infauna and epifauna" as given here. Epifauna, I believe, includes such organisms as starfish.

358. See comment 313 in the Bedford Institute of Oceanography review for a precise terminology.

Section 1.5.15: Seabirds and Waterfowl

358. The number of seabird species which breed in Labrador depends on your definition of "seabird", there are 16: Flumar, Leach's Storm-Petrel, Parasitic Jaeger, Glaucous, Great Black-backed, Herring and Ring-billed Gulls, Kittiwake, Common and Arctic Tern, Razorbill, Common and Thick-billed Murre, Black Guillemot, Atlantic Puffin, Common Eider and Northern Phalarope.

I was disappointed to see the seabirds of Labrador treated so briefly in the Executive Summary, almost as a casual appendix to the sections on benthos and so forth. I realize that the body of the Assesment goes into a great deal more detail, but there are still many gaps there. Besides, executives tend to confine themselves just to reading Executive Summaries, and this particular one is bound to leave them with some incomplete impressions. First, it's important to realize that you can't use simple quantitative yardsticks in assessing the risks of oil pollution to marine biota. There are qualitative considerations to be taken into account as well. I'm not talking about aesthetics, or even about the fact that birdwatchers have greater economic and demotic clout than copepod watchers. The point is that we must think in terms of population dynamics - how many animals there are, and how quickly they can recover from the "unnatural" mortality which follows an oil spill. Seabird populations are very small compared with those of almost everything else in the marine environment, apart from whales and seals. 1 murre does not equal 1 capelin, let alone 1 copepod. The principles of trophic- level biomass suggest that 1 kg of murre = 10 kg of capelin = 100 kg of copepods at the very least, and you'd have to multiply the capelin x 10 and the copepods x 100 to show the orders of magnitude of the numbers of individuals involved. So the chances are that eliminating 1,000 murres out of a Labrador population of c. 65,000 is going to have far more profound effects on the murres than eliminating many times that number would have on the capelin and copepods. Moreover capelin and copepod population dynamics involve a very high rate of mortality combined with very high fertility. This buffers the effect of "unnatural" mortality - the "lost" animals can be quickly replaced, and indeed many of them would have been "lost" to natural mortality anyway, before they were old enough to breed. On the other hand the more specialized seabirds such as murres have both a low natural mortality and a low fertility - murres lay only one egg a year - and they have a long period of pre-breeding adolescence before they even start to lay, and this makes their populations slow to recover from "unnatural" catastrophies - not just oil pollution, but excessive hunting, human disturbance and

drowning in fishing gear as well. And indeed their numbers have declined catastrophically over the last hundred years on both sides of the Atlantic. It's easy to be misled by the often large numbers which still remain at many colonies into believing that the health of seabird populations is a great deal better than it actually is. So I should like to see this greater inherent vulnerability of seabirds discussed more fully in the body of the Assessment, and highlighted in the Executive Summary. I'd like, too, to see the size of the seabird population in Labrador both described more precisely and put into some kind of perspective - again, both in Summary and in the main Assessment. "Very large numbers of Atlantic puffins and common murres..." (p. 1-11) is very vague, and is perhaps less likely to impress the reader than to leave him feeling "what the hell? - so there's plenty more where those came from". So Gannet Islands are the largest Razorbill and the second largest Puffin colony in the western hemisphere, and the third largest Common Murre colony in the western Atlantic. The Razorbill population of Labrador is c. 19,300 pairs (Nettleship 1980, supplemented by Brown et al. 1975 - and not the other way round, incidentally, as these publications are cited all through this Assessment). That's 76% of the population of North America, including Greenland, and c. 9% of the total world population of only c. 210,000 pairs (Lloyd, 1976: British Birds 69: 298-304). A mere 9,370 Thick-billed Murres breed in Labrador. On the other hand, the annual production from the 665,000 pairs in Hudson Strait (over 50% of the Canadian population) comes migrating down the Labrador coast in September, augmented later in the year by about the same number of birds from the Canadian High Arctic and west Greenland. The Hudson Strait birds are at first swimming, each unfledged chick accompanied by a flightless parent. Both Summary and the body of the Assessment should draw attention to the worst-case scenario in which an oil spill off northern Labrador at this time could wipe out a whole year-class from these colonies, along with half of the more successful parents.

358. **The executive summary has been re-written. It appears that the point of this rambling comment is that the executive summary ought to have emphasized that seabirds are more inherently vulnerable to spilled oil than most other marine organisms. Some seabird populations might recover slowly from oil spills because of late age at first breeding, small clutch sizes (often only one egg), and failure to renest after the loss of a clutch. Further, the executive summary did not place the importance of Labrador seabird colonies in a continental or global perspective.**

Section 1.5.16: Page 1-12

359. Is it really true to say that the controversy over the Newfoundland seal hunt has hindered the publication of data on the numbers and population dynamics of seals? I would have thought the converse was true.

359. We stand corrected.

Section 1.6.1: Page 1-13

360. Why tanker spills? The section deals with exploratory drilling impacts.

360. The intention was to set the magnitude of oil blowouts in its proper perspective.

Section 1.6.2

361. Even though the company may have taken steps to ensure that drilling fluids are relatively free from heavy metals, such fluids still contain substantial levels (barite from the Buchan's source is heavily contaminated with heavy metals).

No mention has been made of the disposal techniques for lube oils and deck spills.

361. Some (not all) sources of barite do contain high concentrations of heavy metals.

Section 1.6.3

362. The report tends to downplay the impact of oil blowouts. These are not "relatively minor contributors to the pollution load". Most blowouts in the past have occured well offshore; on pp. 1-14, however, it is suggested that under certain conditions oil could go ashore in less than a day. This is an entirely different "kettle of fish".

362. The IEA did not intend to minimize the impact of oil blowouts. Remember that this comment applies to an executive summary. The IEA devoted 66 pages of text to the issue.

Section 1.6.5: Fate of Oil and Gas Following Blowouts: Page 1-14

363. They report only two instances where normal operations were interrupted. I am aware of a number of other potentially serious incidents off Labrador. While in Newfoundland, I learned of yet another problem which occurred off Labrador during the 1980 season. It

appears a malfunction of the computer positioning system caused the "Neddrill II" to attempt to move off the drillsite at full power while the drillstring was still in place. Fortunately, a manual override was thrown before serious damage was caused. This type of incident hardly leaves one with a feeling of overconfidence!

363. Except for conveying skepticism, what point is the reviewer trying to make?

364. Is this based on oil found off N.E. Newfoundland or Labrador? How comparable are they in terms of their characteristics and fate?

364. This general statement would apply to most crude oils.

365. Last para: All possibilities for oil slick movement are listed. The paragraph however leaves the reader wondering what the author is attempting to say.

365. Perhaps the reviewer didn't comprehend this paragraph.

Section 1.6.6: Page 1-15

366. The Labrador play is a relatively young one. Just because H_2S has not been found to date does not mean it can't be found there in the future.

366. In an infinite world, all things are possible.

367. Surface oil slicks may also impact fish eggs and larvae in surface waters.

Page 1-17: I think this is somewhat of an understatement (remember the polar bear oiling study!)

367. Comments noted.

Section 2.0: Declaration and Need

368. Page 2-1. It is interesting to note that NEP is being quoted as support yet normally the companies have spent considerable effort denigrating the program.

Page 2-2. They have neglected to mention why Eastcan had to re-enter the Lief well begun by Tenneco. This is another instance where discussion of problems is downplayed or entirely neglected.

Page 2-9. Table 2.2 implies that part of the BIOS program falls under OLABS.

Page 2-9 & 2-10. Petro-Canada provided, via their resource people, useful updates on ongoing OLABS studies.

368. Comments noted.

Section 3.3.1: Wind, Wave and Weather Hazards

369. There seems to be some confusion here regarding the difference between a weather report and a weather forecast.

Also, last para: one wonders if undue optimism is not indicated, especially in view of recent events off these coasts.

369. Comments noted. Is the reviewer referring to the sinking of Ocean Ranger?

Section 3.2.4: Support Operations, page 3-8

370. Presumably ceiling and visibility of 122 m and 1.6 km represent "four hundred and one". Since CATA is not yet changing procedures, it would be better to give the conventional figures with SI equivalents in brackets if necessary.

370. Comment noted.

Section 3.3.2: Ice and Icebergs

371. Does pack ice really cover the area for most of the year?

371. Mid-November to late June in some localities. A snarky comment but one which you have to agree with. Change "most" to "much" and everything is fine.

Section 3.4.3: Relief Well, page 3-16

372. In discussion of relief well drilling, the time lapse from spudding to completion should be considered and the probability of effecting relief well completion. This is a very important facet in the short season on the Labrador coast. It is very likely that relief well spudding could be delayed until the following summer if a blowout occurred in October.

372. The general statement of time required to drill a relief well is accurate; a relief well sometimes takes more time to drill than the original well, sometimes less.

Section 4.1.1: Major Environmental Factors

373. Para 2 - What will be the extent of the turbidity plume and how will this affect fishing effort?

Page 4-1. More information should be provided on the scope of the LABORS program off Labrador.

Para 5 - Shut in procedures would "minimize" the loss of product from the well head. This section should include an estimate of loss during shut in.

Page 4-10. The subterranean system would require 26 years of tunnelling. This sounds like a "good make work project" but is not really a viable option.

373. The reviewer missed the point of this section, which was to present general design concepts. Random details such as these are naturally unavailable at this time, because the concepts are at a preliminary stage.

Section 4.2: Timing of Floating Production System

374. Realistically the bottom founded system is not practical in the sea depths and ice conditions encountered in the Labrador sea. This option should be placed in perspective. A similar comment is relative to Section 6.2.

374. It is inappropriate for the IEA to evaluate any of these options; that is the whole purpose of the LABORS project.

Section 5.1.4.4

375. Are boulders found on the seafloor or predominantly buried?

375. They occur in lenses of glacial tills beneath the sea floor.

Section 5.2.1

376. Page 5-24 to 5-29 on Coastlines is particularly well written and illustrated.

376. Thank you.

Section 5.2.4: The Coastal Environment, Page 5-26

377. This initially attractive diagram does not really stand up to close examination. Where, for example, are the 34 km/h winds measured - at sea, in constraining topography, north or south, etc? Are those coastal, shore-

line or deep sea waves? What are the air temperatures over the water?

377. It seems the reviewer missed the point of this diagram, which was to give a generalized overview of the annual cycle of coastal processes.

Section 5.2.4.1: Distribution of Coastal Environments

378. The reference to Bauer and Martin is for conditions in the Bering Sea. Is this description applicable to the Labrador Coast?

378. There is no reference to Bauer and Martin in Section 5.2.4.1.

Section 5.3

379. Page 5-60 to 5-66 is one of the poorer sections of the report. Table 5.5 is not very informative. I would tend to disagree that soil properties, landslides, sediment transport and earthquakes would not affect drilling.

Page 5-63. No conclusions have been drawn relative to the significance of landslides on the Labrador Shelf. Discussion of the possibility of liquifaction of soils has been delayed until site-specific studies are undertaken. Can no interim "best guesses" be made?

Sediment transport and boulder beds obviously require further study.

Page 5-64. The section on iceberg scouring is entirely inadequate. In view of the significance of this problem, I would have thought more effort would have been expended here!

Page 5-65. Figure 5.19 and the results of Basham's work suggest that at least farther offshore Labrador falls outside Zone 1.

379. Comments noted.

380. Page 5-145. Where is the data on background heavy metal levels in water and sediments?

380. There appear to be no data on heavy metals, unless they are in unpublished EPS files.

381. The section on background hydrocarbon levels is not the entire literature on the subject. Other surveys have been carried out by BIO.

Page 5-151. It is interesting that phytoplankton production can be measured to such accuracy (i.e. - 500 mg C/m/day).

381. The BIO reviewers, Levy and Jones, did not mention this information in their critiques. Is the DOE reviewer certain that this information exists?

382. Page 5-157. The paucity of data suggests that a study of epontic communities off Labrador is warranted.

382. See response 348.

Section 5.4.1: Regime

383. First year ice also develops in the Labrador Sea and not only in the Arctic as stated. Also ice which forms in Foxe Basin, Hudson Bay and in most of Hudson Strait does not drift out to the Labrador Sea.

383. ALL ice from these regions does not decay in situ, SOME ice is removed from those regions and enters the Labrador Sea. We never mentioned Foxe Basin, Hudson Bay, and Hudson Strait - they did; we referred only to the Arctic.

384. The treatment of ice floe size (Bauer and Martin, 1980) does not specify area, time of season or amount of ice involved. Some mention of the data base used should be included. The description of the marginal ice zone appears to be over-simplified. The width of the seaward edge zone is not characteristically 5 to 10 km as suggested; it is extremely variable up to 100 km in width and often in the form of strips and patches of ice of high concentration. The description given conflicts with section 5.4.7.5. The reference to energy of the transition zone is not clear.

384. The timing of the season for each of these types is site dependent. Some sites may see all zones, some only one or two, some none and some many transitions through the zones. The model is simple; it is a very simple model of a complex situation. The length scales are debatable; show me alternative evidence to support their comments as I have seen none published. It does NOT conflict with 5.4.7.5. It actually provides a mechanism to explain the differences in the observations eg. C-CORE/NORDCO - edge zone; AES - interior zone.

Section 5.4.2: Extent and Duration

385. The statement that a composite ice map depicts conditions for an entire ice season is absurd. It would be

more sensible to construct a chart of maximum ice conditions during the season.

Fig. 5.20, taken from AES Ice Atlas does not contain the proper labelling. At the end of December ice conditions in southern Labrador are typically the following:

Total ice cover - 14% (86% open water)			
Constituents:	New Ice	8.4%	coverage
	Grey Ice	1.4%	"
	Grey White	2.5%	"
	First Year	1.7%	"

The descriptions presented in the document lack continuity and appear to be collected from a variety of sources rather than resulting from an in-depth study of sea ice information. Such a study is available.

385. Composite maps are used by AES Ice Branch; obviously they do not consider them "absurd". Composite ice maps have utility in depicting a "median" or "average" ice year. These can be useful in defining operational scenarios. Maximum conditions are of little use for planning under normal conditions. They present only the worst case scenario. The figure is an exact reproduction from Markham's atlas. No title is given in Markham for his figures and the one chosen was felt to be appropriate. The author of the comment does not know how to interpret the figure; the ice compositions are in relative numbers. By reading the graph for the end of December one obtains an ice cover of 15% of which 60% is new ice (.60x15%) = 9%
9% is grey ice (.09x15%) = 1.4%
18% is grey white ice (.12x15%) = 1.8%
12% is first year ice (1.2x15%) = 1.8%.
As can be seen, there is no contradiction. Please identify the "in depth study of sea ice information" which is available. Most studies deal only with selected aspects of the entire subject. Much of the knowledge presented was drawn from proprietary reports and this could not be found in any public domain study.

Section 5.4.5: Ice Thickness

386. This section is generally acceptable but contains a reference to Table 5.7. This table contains thickness data taken from several FENCO reports. These reports should be examined for consistency in their definitions of white ice, first year ice and grey ice.

386. The data presented in Table 5.7 are quantitative results and thus independent of any qualitative label. Where

possible in the text, W.M.O. terminology was employed with the following categories:

new	0-10 cm
grey	10-15 cm
grey white	15-30 cm
first year	>30 cm

Section 5.4.6: Deformation

387. The landfast ice zone is generally smooth with a few ridges produced by thermal expansion except in the vicinity of the outer edge where considerable interaction with pack ice occurs. The report does not examine shore ice features in any depth.

Comments respecting consistency of definitions of ice types made earlier for Table 5.7 apply also to Table 5.8.

387. Land fast ice is not examined in depth because the exploratory drilling does not take place in region of land fast ice. The mobile ice zone was considered to be the most appropriate ice environment to examine in detail.

Section 5.4.8: Origin of Icebergs

388. Only one reference for information on iceberg source regions is cited. Some available literature mentions as many as 40,000 bergs calved in Baffin Bay.

388. The source quoted in the I.E.A. was considered to be the best available. The 40,000 figure was in a review paper by Murray which was based on the work of Kollemeyer; the 10,000 figure is a revision of earlier work. Certainly, the sampling program is of concern and we are aware of its nature, but it is the best available.

Section 5.4.9: Iceberg Flux

389. International Ice Patrol data reflect the fact that little data extends beyond 100 miles of the coast. Thus to some degree these data are biased towards greater numbers of bergs being shown near the coast.

389. The routing is also an iterative procedure and all surveys must make tradeoffs between coverage, ability and resources.

Section 5.4.11: Iceberg Dimensions

390. Para 4 - change 25 - 30 tonnes to 25 - 30 million tonnes.

390. **Agreed, the figures quoted are in millions of tonnes.**

Section 5.5.1: Data Base for Climatology

391. OSV Bravo did not operate at the indicated location (56.5N, 51.0W) until January 1, 1946, not 1945 as stated on page 5-89 or 1942 as stated on page 5-128. Prior to this its station location was at 55.5N, 44.0W starting May, 4, 1945.

Page 5-91. Perhaps the phrase "...were not taken randomly in space or time" should be changed to "...were not taken uniformly in space or time".

391. **Comments noted.**

Section 5.5.2: Atmospheric Pressure and Winds

Figs. 5.28, 5.29, 5.30, 5.31 and 5.32

392. The note on page 5-92 confuses "isobars" with "isopascals". It is regrettable that wind speeds are not given in knots since this is still the marine usage. The mean speeds for L4 and Danard's 3 do not seem to have been included. The figure 9.7 at Bravo in April should probably be 19.7. The note on wind speeds on the April chart is incomplete and on this same page the map position of Bravo is joined to the rose for L4.

Fig. 5.29. Calms for Cartwright wind rose should be 7% rather than 2%. The Hopedale wind rose has been labelled Battle Harbour and vice versa. Labels for OSV Bravo and SSMO area L4 have been interchanged.

Fig. 5.30. The mean wind frequency for a southerly direction should be 26 for Battle Harbour rather than the value given.

Fig. 5.31. The mean frequencies for NNE and SSW winds have been omitted for Hopedale. Also the OSV Bravo wind rose has been mislabelled SSMO area L4. The percent frequencies for this wind rose have been wrongly labelled.

The statement that the figures are derived from Meserve is only partially correct since isotachs have been added near the coast. This addition, furthermore, is only partially correct since it is based on overload wind speeds which are not directly comparable to the SSMO based wind speeds. The magnitude of the decrease in mean wind speeds westward from Bravo is not as great as suggested. Based upon actual Bravo data the 100 year wind at this site is 49 m/s.

Page 5-98. The reference to "Newfoundland Island" (para 2) may be an error. The wind speeds quoted (from Vandall) should be in knots not m/s. A reference to the 1968 wind normals publication is regrettable since that publication does not appear to be in the bibliography while the more recent one with 1955-1972 data is.

Hurricanes are never "decadent". The writer obviously is confused by the meaning of "extra tropical". As in other studies which we have reviewed, it would appear useful to mention that winter storms in this area are likely to be more dangerous than the remnants of disturbances of tropical origin.

Section 5.5.4: Visibility and Ceiling

Table 5.11 - Ledrew and Gustajtis are not the only source of the information displayed here.

Page 5-102. Blowing snow is not the only cause of reduced winter visibilities.

Fig. 5.33. 4°C sea surface isotherm omitted around Greenland on July map.

Fig. 5.34. The usefulness of this figure would be much enhanced by including ranges.

Table 5.12. Data for October and November should be added.

Section 5.6.4.1: Sources of Information, Page 5-130

The statement that hindcasting has a serious disadvantage due to the fact that pressure distributions are available only from extrapolation from land based stations is only partially correct. Ship data are available and upper air data can be used to deduce surface features. Undoubtedly some small scale features have been missed over the years.

It is difficult to understand how a 7-year cycle can be detected from 11 years of data.

The problem associated with ship's period data is illustrated by Table 5.16 where the most common period is "indeterminate". Compare this to Bravo data, where trained observers label only 5% of the data as indeterminate period and where the most probable period is 6 - 9 seconds. The difference between the visual and wave rider period values is more likely due to observer error than observing method. In addition, it has been speculated that periods in excess of 14 seconds may sometimes be coded incorrectly due to the nature of the

coding format. This would result in periods of 15 and 16 seconds being coded as 5 and 6.

Neu's design values are not directly comparable to the Baird and Marex data since Neu's values are for maximum wave as opposed to significant wave. Dividing Neu's values by 1.8 - 2.0 gives values similar to the other two.

392. Corrections noted.

Section 5.6.4.2: General Way Condition

393. Table 5.16 contains 4 errors in the first row.

Page 5-132. Twice on this page 40 feet is equated with 5 metres. The desired figure is probably 12 metres.

393. 40 feet is correct.

Section 5.6.4.3: Extreme Wave Conditions

394. Given the limited data base, the 1:50 and 1:100 expectations will have rather wide ranges at, say, the 95% confidence level. This should be indicated - the upper limits may approach agreement with Neu's estimates.

394. Agreed. There was no quantitative comparison, but Neu's results also had extremely wide confidence limits. None are really trustworthy.

Bibliography - Physical Environment, pp. 5-272 to 5-334

395. 5-282 A more recent version of W.T.R. Allen's publication is available.

5-273 The AES Ice Atlas has been published.

5-274 The Hydrological Atlas was published in 1978. The Canadian Normals for Wind should be with other AES references on 5-272.

5-283 The Markham reference is incomplete. See also 5-273. What about Sowden and Mudry?

5-285 The comments about SSMO's being unpublished are puzzling.

5-288 Stallabrass is incorrectly spelt.

395. Comments on bibliography noted.

<u>Section 5.9.2.2: Seasonal Patterns of Distribution and Abundance</u>

396. Page 5-152 para 2: The Davis Strait population may not be directly comparable to the Labrador Sea although I can see where they may be similar. Additional work should be conducted to develop information for the Labrador Sea.

Page 5-153 para 3: The above comment is more important when Buchana's and Foy's work is considered.

396. Additional work is not an industry priority at this time. See response 347.

<u>Section 5.9.2.3: Productivity and Standing Stock Biomass</u>

397. There appears to be a need to produce more information on the biomass of phytoplankton of the Labrador Sea. There are considerable differences, based on the limited data available, between the Labrador Sea and the Davis Strait and Frobisher Bay areas.

397. See response 396.

<u>Section 5.9.3: Epontic Community</u>

398. Given the percentage contribution of the epontic community to the total annual food production of Frobisher Bay, 2-20%, I believe that epontic community work should be conducted in the larger embayments and Fjords on the coast most likely to be oiled during a blowout.

398. See response 348.

<u>Section 5.10.2: Principal Species</u>

399. Since the copepod <u>Calanus finmarchicus</u> is such a major portion of the zooplankton on the Labrador coast, this species should be used to determine the toxicity of oil and drilling mud and cuttings. A severe impact on C. finmarchicus could seriously affect the commercial fishery.

399. See response 349. Because of the broad geographic distribution, relative abundance and reproductive rates of calanoids, it is unlikely that even a large oil spill would have a severe impact on <u>Calanus</u>. It could be a useful study organism for monitoring purposes, however.

Section 5.11.4: Biomass and Community Structure

400. Page 5-167 - The detailed descriptions of the station presented here are really not necessary to the text.

400. Perhaps. However, these descriptions relate the distribution of benthic communities to physical parameters such as substrate, exposure and depth.

Section 5.11.5: Economically Important Invertebrates

401. The juvenile development of P. borealis in shallow water makes this species very suceptible to impact from oil spills. The possible juvenile development areas should be identified, if possible, for protection in the event of a spill.

401. Suggestion noted.

Section 5.15.3: Sensitive Areas and Time Periods

402. Table 5.27 gives no figures for the number of Kittiwakes which breed on the Buttons and the Knights; actually, c.750 and c.660 pairs, respectively. I found Figs. 5.57 and 5.58 confusing, a. because the definitions of "Winter" and the other seasons aren't given, b. because the shading chosen is darkest for the lowest densities and c. because lumping species of so many different kinds (especially in Fig. 5.58) is so broad that it tells one very little, even if you believe that the number of birds seen per 10 minutes from a moving ship is the same as the number per km^2 from a low- flying aircraft, and I for one don't. Contrary to Fig. 5.59, there isn't a major concentration of Eiders on the Buttons.

Section 5.15.4.2: Procellariiformes

Page 5.240, para. 1: Brown et al. 1975 don't state that Fulmars "first appear off the northeast Labrador coast about April". We weren't up there before April, that's all. Far from it, Brown 1979 (based on MacLaren-Marex surveys) shows that there are some birds up there in January. I imagine the main limitation to their distribution is pack-ice. Para. 3: the spread of the Fulmar into Atlantic Canada has almost certainly been a westward one, from the expanding population in the eastern Atlantic, rather than a southward one from Greenland or the Canadian arctic. Para. 5: the European Arctic birds which I measured off Labrador were caught in early May; by no stretch is that "summer", in Labrador. My guess is that Spitsbergen Fulmars, like Spitsbergen Dovekies and Thick-billed Murres, cross the

Atlantic and winter off southwest Greenland and in the Labrador Sea.

Page 5.241, paras. 2,3: both Greater and Sooty Shearwaters occur quite commonly all the way up the Labrador Banks and across to Greenland.

In August, after the capelin season, presumably Greaters are commonest towards the outer edge of the Banks, and they stay there until it's time to go south in October. Sooties come through only in passage for the eastern Atlantic, and they are commonest very close inshore. Para. 3: there's also a major Leach's Storm- Petrel colony on Baccalieu Island, eastern Newfoundland. I don't know where the species winters - perhaps in tropical convergence and upwelling zones - but it isn't off the Atlantic Provinces.

Section 5.15.4.3: Pelecaniformes

Page 5.242, para. 2: immature Gannets stray in summer as far north as Hudson Strait.

Section 5.15.4.4: Onseriformes

Page 5.243, para. 3: Lock didn't record Barrow's Goldeneyes on his surveys because they were impossible to separate from the air, not because they weren't there.

Section 5.15.4.5: Charadriiformes

Page 5.248, para. 5: Brown *et al*. 1975 on jaegers was based on Godfrey, and we misquoted him. Yes, there are parasitic jaegers breeding in northern Labrador, as far as I know.

Page 5.251, para. 2: Lambert (1973 ref. in Brown *et al*.) is a better reference on both the spring and fall migrations of Sabine's Gulls off Labrador. His guess is that they fly directly across from Europe, and that Labrador is their first landfall (or, of course, their last) on this side of the Atlantic. Para 5: the percentage of the New World Razorbill population which breeds in Labrador is variously stated, here and elsewhere in the Assessment, as 70% or 60%. My own calculation, above, which involves some guesses for the size of the Greenland population, is 76%.

Page 5.252, para. 2: there has to be a better reference for the nesting habits of Razorbills than Northlands (1977a). Try Bedard (1969; ref. in Brown *et al*.). They do in fact nest in small colonies. But it's always best to go back to an original reference - not least because

many consultants' reports of that period were full of mistakes which other consultants, by incestuously quoting, recycled over and over again.

Page 5.253, para. 1: I suspect that Tuck's interpretation was an artifact of recovery bias. The topography is such that the chance of a banded murre being recovered north of the Funks is far greater than from the south and there's virtually no chance at all of finding one on the Grand Banks. My guess is that they disperse in all three directions. The ones which reach Labrador don't seem to get much north of Belle Isle. Para. 2: Gaston (1980: GUS Progress Note No. 110) is the best reference for the number of Thick-billed Murres which winter off eastern Newfoundland (and, by implication, get there via the Labrador Banks). Para. 3: says nothing about the wintering areas of the two murre species because the Grand Banks are influenced by the Labrador Current. Brown et al. 1975 is in fact silent on the topic. To judge from the species composition of oil kills in winter farther south, I think that Common Murres winter well south, perhaps on the Scotian Shelf and Georges Bank, though the Tail of the Grand Bank can't be ruled out. Try Brown (1968; ref. in Brown et al.) for the timing of the spring migrations of auks in the Labrador Sea. Para. 5: Dovekies are by no means always "fairly evenly distributed" in offshore waters in winter. Brown (190a; Trans. Linn. Soc. N.Y. 9: 15-22 - fig. 1) has on occasion found them highly concentrated on the western slope of the Grand Banks, and also (in prep.) on the slope southwest of Sable Island. Both are upwelling areas, presumably with high local prey concentrations. It might be possible to locate likely areas of this kind from satellite photographs, and I have in fact done this for Labrador Sea Red Phalaropes in late summer (Brown 1980b; Seabirds as Marine Animals, in Behavior of Marine Animals, vol. 4, Burger Olla and Winn eds., Plenus Press, NY). Bear in mind, though, that fronts of this kind can be upset by strong gales. I also found abundant Dovekies at ice-edges in Baffin Bay in August (Brown 1980b), and off east Greenland in March (in prep.). The same might be true of ice-edges off Labrador, though I suspect that these may be formed of ice too young to support much of an epontic fauna. See also Bradstreet 1976, 1977, now published in Can. J. Zool, and LGL's spring surveys ca. 1978/9 in the North Water.

Page 5.254 para. 3: Brown (in prep) found Black Guillemots at the ice-edge off Greenland as well, and see also Bradstreet for northern Baffin Bay. Again, the birds might winter there off Labrador. para. 4: "Puffins are largely pelagic, coming to land only to breed". Well, that's true of every other Atlantic alcid

apart from Black Guillemots, to say nothing of Fulmars, Leach's Storm-Petrels, Kittiwakes... We just don't know where Puffins spend the winter on this side of the Atlantic; they simply vanish. If European banding patterns are any guide, our birds go south - but where? We in turn get Puffins from Iceland.

402. **Comments and corrections noted. We appreciate these new sources of published and unpublished information. The IEA would have been much improved by incorporating Dr. Brown's comments into the final draft.**

Section 5.16.2: Seals

403. Page 5.256 para. 4: I'd have thought that Ringed Seal pups would be even more susceptible to predation by polar bears. I had an idea that Bearded Seals (5.256, para. 5) sometimes also went quite deep, and fed on the bottom like minature walruses? Bowheads (5.264, para. 7) wintering off southwest Newfoundland seem very far south. How sure were Parsons et al. of their identifications? - Rights sound more likely.

403. **Comments noted. See also DFO comments on marine mammals.**

Section 6.2.1: Introduction

404. Para. 2: It is true that routine drilling is unlikely to affect the biological events depicted but an uncontrolled well releasing oil or condensate or hydrated gas over the winter months may affect any or all of these events.

404. **This comment might be partly true, but is irrelevant to the topic at hand: the effect of routine drilling operations.**

Section 6.2.2: Disposal of Drilling Fluids

405. Page 6-4 and Table 6.1: When reference to Lignosulfonate is made is it actually Ferrochrom lignosulfonate. If so then the chromium content of the mud system should be noted.

405. **Ferrochrome lignosulphonate is one of several lignosulphonate compounds used as mud additives.**

406. Table 6.2: The LC50 values for NAOH and $NaHCO_3$ do not agree with other LC50 data produced for Beaufort Sea drilling.

406. **The source of the LC50 values is Baroid of Canada Ltd. The reviewer may have used other authorities. The important point is the high acute toxicity of NaOH.**

Section 6.2.4

407. Page 6-10. It is interesting to note that Table 6.4 gives relatively low heavy metal levels for Petro-Canada's barite source. (At the workshop, Petro-Can officials noted that barite will be obtained from Buchans. This source is high in arsenic, cadmium, mercury, copper, iron, lead and zinc. There seems to be an inconsistency here!)

407. **Table 6.4 presented a heavy metal assay of 1981 barite, which was from another source of supply. Petro-Canada policy is to use "clean" barite sources, when available.**

408. Page 6-13. The authors use a 1977 reference to suggest that spills from offshore production are among the lowest contributors to the estimated total of oil entering the sea. Unfortunately, these studies do not include the large discharges associated with the "EKOFISK" blowout in the North Sea or the "IXTOC" blowout in the Gulf of Mexico; the latter represents the all time largest single discharge of oil, some 140 million gallons.

More recent exploration/production and blowout statistics are available than those quoted.

Since 1976, there have been at least 5 serious blowouts in the Gulf of Mexico and 2 more in the North Sea. Recent statistics suggest 2 blowouts (all types) per 1,000 wells drilled on the US OCS. Blowouts of oil alone occur 5 times more frequently offshore than on land.

The worst offshore oil well blowouts in terms of the amount of oil released occurred in 1969, 1970, 1977 (2) and 1979 (Santa Barbara, 18,500-780,000 bbls., Gulf of Mexico, 53,000-130,000 bbls., Gulf of Mexico, 30,500 bbls., North Sea, in excess of 1 million bbls., and Gulf of Mexico, in excess of 3 million bbls.).

408. **The Ekofisk blowout was from a production well, while the procedures used to drill Ixtoc were greatly at variance from standard exploratory drilling procedures. Nonetheless, it is true that these incidents were serious environmental emergencies.**

Probably the best source of information is the Gulf Oil Corporation (1981) Analysis of Accidents in Offshore

Operations where Hydrocarbons were Lost. That study analyzed 2,500 accidents between 1955 and 1980. Unfortunately, the study was unavailable at the time the IEA was being written.

Section 6.2.5: Accidental Spills of Fuel, Lubricants and Chemicals

409. There should be an evaluation of the effects of chronic pollution.

409. **During the Labrador exploration program many exploratory wells have been drilled, and tested, then suspended or abandoned. Thus no well site is "chronically polluted" in the sense that the reviewer has in mind. There is a possibility (very small) for recurrent spills to occur during fuel transfer operations at St. John's, Goose Bay and the transit bases. As noted in the IEA, these are addressed by the Contingency Plan.**

Section 6.4

410. Page 6-19. The two incidents listed here are not the only ones that have taken place off Labrador (see earlier comment).

Table 2.1 shows 26 wells drilled off Labrador, not the 24 stated here.

410. **This reviewer has been very mysterious about the time and place of other incidents where well control supposedly has been threatened, and has hinted darkly that Petro-Canada is attempting to suppress this information. (See comments 368, 362, 363). The incidents described in Section 6.4 of the IEA are the only ones known to the editor of the IEA and to Petro-Canada offshore drilling engineers.**

Section 6.6.1: Water Quality

411. Page 6-38, Para 3: Second sentence confirms my concerns for Pondulus on the Labrador coast and lends greater need for the work.

411. **Why should Pandalus borealis be considered more vulnerable than other estuarine species to the sinking of oiled sediments?**

Section 6.7.6: Birds

412. Page 6.65 and/or 6.68-9: A bird with oiled plumage and reduced buoyancy may well freeze or starve before it can drown. Don't forget that it's carrying around perhaps 10% extra weight of water-soaked feathers, and that's

going to add to the energetic requirements of foraging just when it needs extra food to counteract the loss of insulation. Note that sublethal effects are more complicated than stated, and still not fully understood and indeed controversial. But there's some evidence that ingestion of oil will stunt the growth rates of chicks of seabirds (e.g. Black Guillemots), and this could lead to them fledging either late or underweight - both could be fatal especially in a short low arctic season like Labrador's. Oil ingestion has been shown to delay ovulation in Japanese Quail and that could have the same effect, though I'd like to see this repeated on a seabird. Note another implication of oil transferred from feathers to eggs in something like a murre. The bird only lays one egg and while she will replace it if it's lost early in the season, she will continue to incubate an infertile egg - so 1 dead egg = 1 wasted breeding season.

412. Comments accepted. The IEA could have quoted the work of Peakall and his co-workers more extensively when the lethal and sublethal effects of oil on birds was being discussed.

413. Page 6.65, para. 3: Leach's Storm-Petrel is not all that common off Labrador. The commonest dabbling duck in Labrador is the Black Duck and that does on occasion feed in tide marshes - which, as we know from ARROW, AMOCO CADIZ and the rest, are liable to oil pollution.

413. Comments noted. They do not invalidate the general conclusions of this paragraph.

414. Page 6.66, para. 2: See what I've already written about Greater and Sooty Shearwaters. Para 3: I've actually seen Wilson's Storm-Petrels, and Fukmars, attracted to a minor oil leak (bilgewater washings) from a ship off Labrador, so this expands the concept of vulnerability somewhat. Para. 5: eiders are seldom seen out of sight of land, at least in Atlantic Canada. Their vulnerability is therefore to an offshore spill drifting in; this isn't made clear. The fact that they are rather social birds, and their Labrador population is small, makes them more vulnerable than, say, a Black Duck in a marine situation.

Page 6.67, para. 1: Scoters need not necessarily be all that less vulnerable, just because they're non- breeding birds. Para. 5: "large flocks" is misleading when applied to jaegers - 50-70 birds would be exceptionally big, for them. Para. 4: you should make it clear that the aspect of the Kittiwake's pelagic habits which make it more vulnerable than other gulls to oil is that it goes so far offshore that it rests on the water instead

of coming regularly back to land like the others. This naturally increases the chances of contact with oil and, because it is so far out, there's no way it can get out of the water and try to preen it off.

414. **Comments noted.**

Section 6.8: Oil Spill Scenario for the Labrador Sea

415. Page 6-73. How can a tentative assessment of the ecological impact of a well blowout be made using information gained during the OLABS and LABORS programs when the data from these studies were received too late to be incorporated in the IEA?

415. **Some of the reports had been received (whales, seals, seabirds, plankton, fishes, benthos) and some had not (e.g. zooplankton) when the writing of the IEA began.**

416. Page 6-74 and 6-75. The indirect impacts of oil on epontic communities as a result of ice degradation (see page 6-49) have been ignored here.

416. **There was no interpretation of the effects of oil on the epontic community because the results of BIOS were then unavailable.**

417. Since some species of Calanis can injest and excrete oil it does not necessarily follow that C. finmarchicus is one of those species. This should be investigated.

417. **Perhaps Calanus finmarchius differs from other congeners in its ability to ingest and excrete oil. See response 349.**

418. Page 6-75 - Pelagic invertebrates. In Section 5.11.5 it states that P. borealis spends approximately 1 year in shallow water during juvenile stages and may well be somewhat sedentary during this period. Investigation of the toxicity of oil and oily residues on juvenile P. borealis would be worthwhile.

418. **Recommendation noted.**

419. Page 6.78, para. 4: Yes, the common phalarope off Labrador is the Red; Northerns probably migrate overland. The key to phalarope distribution at sea (Brown 1980b) is the presence of fronts, tide-rips and similar mechanisms which concentrate their food for them right at the surface. The shelf-edge front off the Labrador coast is one such area where they would be especially vulnerable.

419. **Comment noted.**

Section 8.6.2: Chemical Studies

420. Page 8-17. Analysis of heavy Metals ... It would be worthwhile during these studies to include levels in invertebrates and possibly some histopathological work similar to that conducted by Canmar on old sites. This would not require that much additional effort in sampling although the cost of analytical work would be high.

420. See response 350. Because of faulty design, this study is hardly a model on which to pattern monitoring studies.

Section 8.6.5: Meteorological Studies

421. It is suggested that automatic weather stations could be installed on some of the small islands remote from the shore which would serve a dual purpose (a) enhance data bank, (b) determine statistics of visibility and ceiling parameters as an aid to aviation and possibly yield real time data for this purpose.

421. Recommendation noted.

422. The section on "Social Conditions" is a good attempt to provide a concise picture of social and economic conditions on the Labrador coast. There is, however, no discussion of the land use planning implications of the onshore activities required to support the exploratory drilling or production phases of the project. It would be useful to see:

(a) An evaluation of the effects on local land use and land use planning, if any, of existing onshore activities undertaken to support the exploratory drilling phase now in operation.

(b) An undertaking by the proponent to ensure that an evaluation of the potential socio-economic and land use implications of on-shore developments required to support both drilling and production phases is completed in consultation with the province and local municipalities.

422. It would have been premature for the IEA to evaluate the land use planning implications of production. The recommendations respecting planning have been forwarded to social affairs for evaluation.